الجمهورية الجزائرية الديمقراطية الشعبية
Democratic and Popular Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research

University Mohamed Seddik Benyahia -Jijel-

TRAINING OFFER
LMD

ACADEMIC BACHELOR

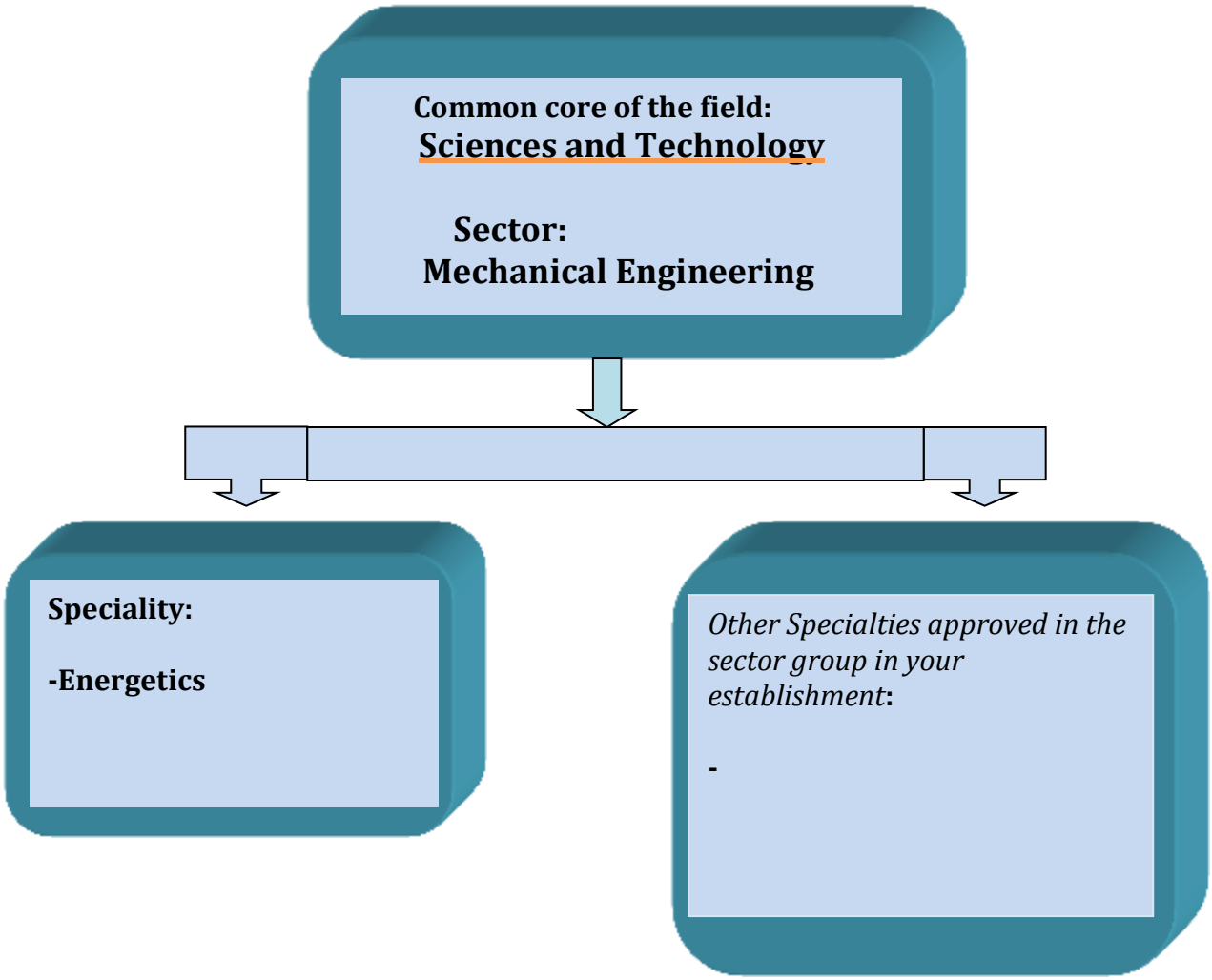
NATIONAL PROGRAM

Establishment	Faculty	Department
University Mohamed Seddik Benyahia - Jijel	**Faculty of Sciences and Technology**	**Mechanical Engineering**

Domain	Sector	Speciality
Sciences and Technology	***Mechanical Engineering***	***Energetics***

CPNDST

I–License Identity Card



II – Half-yearly teaching organization sheets of the specialty

Semester 1(Common Core – Science and Technology)

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 1.1 Credits: 18 Coefficients: 9	Mathematics 1	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	Physics 1	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	Structure of matter	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	Physics 1 Practical Work	2	1			1h30	10:30 p.m.	27:30	100%	
	Chemistry 1 practical work	2	1			1h30	10:30 p.m.	27:30	100%	
	Computer Science 1	4	2	1h30		1h30	45h00	55h00	40%	60%
	Writing methodology	1	1	1 hour			3:00 p.m.	10:00 a.m.		100%
EU Discovery Code: UED 1.1 Credits: 1 Coefficients: 1	Careers in science and technologies 1	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 1.1 Credits: 2 Coefficients: 2	Foreign language 1 (French and/or English)	2	2	3:00 a.m.			45h00	5:00 a.m.		100%
Total semester 1		**30**	**17**	**4:00 p.m.**	**4:30 a.m.**	**4:30 a.m.**	**375 hours**	**375 hours**		

Semester 2 (Common Core – Science and Technology)

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 1.2 Credits: 18 Coefficients: 9	Mathematics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Physics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Thermodynamics	6	3	3h00	1h30		67h30	82h30	40%	60%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	Physics 2 Practical Work	2	1			1h30	10h30	27h30	100%	
	Chemistry 2 practical work	2	1			1h30	10h30	27h30	100%	
	Computer Science 2	4	2	1h30		1h30	45h00	55h00	40%	60%
	Presentation methodology	1	1	1 hour			3h00	10h00		100%
EU Discovery Code: UED 1.2 Credits: 1 Coefficients: 1	Careers in science and technologies 2	1	1	1h30			10h30	2h30		100%
Transversal EU Code: UET 1.2 Credits: 2 Coefficients: 2	Foreign language 2 (French and/or English)	2	2	3h00			45h00	5h00		100%
Total semester 2		**30**	**17**	**4h00**	**4h30**	**4h30**	**375 hours**	**375 hours**		

Semester 3(Common Core - Mechanical Engineering)

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Mathematics 3	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	Waves and vibrations	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Fluid mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Rational mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	Probability and statistics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Computer Science 3	2	1			1h30	10h30	27h30	100%	
	Technical drawing	2	1			1h30	10h30	27h30	100%	
	TP Waves and vibrations	1	1			1 hour	3h30	10h00	100%	
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	Basic technology	1	1	1h30			10h30.	2h30		100%
	Metrology	1	1	1h30			10h30	2h30		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Technical English	1	1	1h30			10h30	2h30		100%
Total semester 3		**30**	**17**	**1h30**	**7h30**	**4h00**	**375 hours**	**375 hours**		

Semester 4(Common Core - Mechanical Engineering)

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 2.2.1 Credits: 6 Coefficients: 3	Thermodynamics 2	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical Manufacturing	2	1	1h30			10h30.	27:30		100%
Fundamental EU Code: UEF 2.2.2 Credits: 8 Coefficients: 4	Mathematics 4	4	2	1h30	1h30		45h00	55h00	40%	60%
	Numerical methods	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 2.2.3 Credits: 4 Coefficients: 2	Resistance of materials	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 2.2 Credits: 9 Coefficients: 5	Computer Aided Design	2	1			1h30	10h30	27 h30	100%	
	Practical work on fluid mechanics	2	1			1h30	10 h30	27 h30	100%	
	Numerical Methods Practical Work	2	1			1h30	10 h30	27 h30	100%	
	Practical work on resistance of materials	1	1			1 hour	3h00	10 h00	100%	
	Mechanical Manufacturing TP	2	1			1h30	10h30	27 h30	100%	
EU Discovery Code: UED 2.2 Credits: 2 Coefficients: 2	Industrial electricity	1	1	1h30			10 h30	2 h30		100%
	Materials Sciences	1	1	1h30			10 h30	2h30		100%
Transversal EU Code: UET 2.2 Credits: 1 Coefficients: 1	Expression and communication techniques	1	1	1h30			10 h30	2h30		100%
Total semester 4		**30**	**17**	**12h**	**6h.**	**7h.**	**375 hours**	**375 hours**		

Semester 5(Energetic)

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 3.1.1 Credits: 10 Coefficients: 5	Fluid Mechanics 2	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	Heat transfer 1	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 3.1.2 Credits: 8 Coefficients: 4	Turbomachines 1	4	2	1h30	1h30		45h00	55h00	40%	60%
	Energy conversion	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 3.1 Credits: 9 Coefficients: 5	Heat Transfer TP	2	1			1h30	10 h30	27:30	100%	
	TP Turbomachines 1	2	1			1h30	10 h30	27:30	100%	
	Energy Conversion TP	2	1			1h30	10 h30	27:30	100%	
	Measurement and instrumentation	3	2	1h30		1 hour	37h30	37h30	40%	60%
EU Discovery Code: UED 3.1 Credits: 2 Coefficients: 2	Concept of machine elements	1	1	1h30			10 h30	2 h30		100%
	Regulation and control	1	1	1h30			10 h30	2 h30		100%
Transversal EU Code: UET 3.1 Credits: 1 Coefficients: 1	Environment and sustainable development	1	1	1h30			10 h30	2 h30		100%
Total semester 5		**30**	**17**	**1** h30	**6** h30	**5** h30	**375 hours**	**375 hours**		

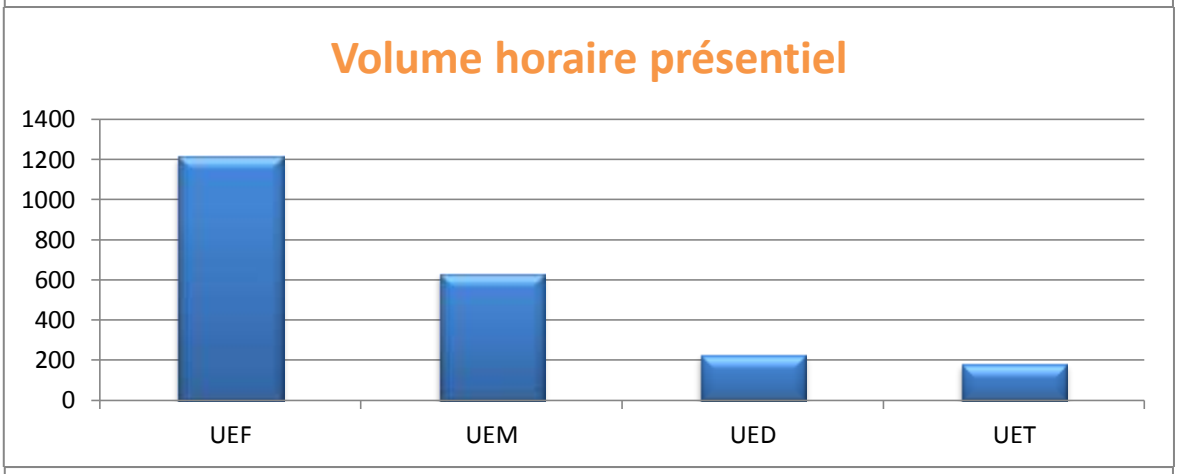
Semester 6(Energetic)

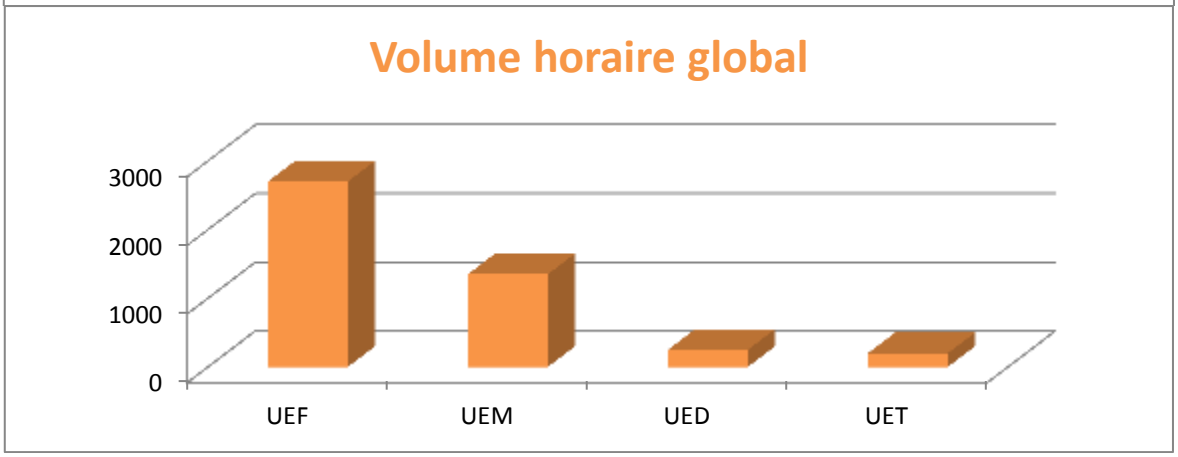
Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Assessment method	
	Titled			**Course**	**TD**	**TP**			**Continuous Assessment**	**Exam**
Fundamental EU Code: UEF 3.2.1 Credits: 10 Coefficients: 5	Turbomachines 2	6	3	3:00 a.m.	1h30		67h30	82h30	40%	100%
	Internal combustion engines	4	2	1h30	1h30		45h00	55h00	40%	100%
Fundamental EU Code: UEF 3.2.2 Credits: 8 Coefficients: 4	Refrigeration machines and heat pumps	4	2	1h30	1h30		45h00	55h00	40%	100%
	Heat transfer 2	4	2	1h30	1h30		45h00	55h00	40%	100%
Methodological EU Code: UEM 3.2 Credits: 9 Coefficients: 5	End of Cycle Project	4	2			3h	45h00	55h00	100%	
	TP Refrigerating Machines and Heat Pumps	2	1			1h30	10 h30	27:30	100%	
	Internal combustion engine TP	1	1			1 hour	3h	10h	100%	
	TP regulation and control	2	1			1h30	10 h30	27 h30	100%	
EU Discovery Code: UED 3.2 Credits: 2 Coefficients: 2	Renewable energies	1	1	1h30			10 h30	2 h30		100%
	Cryogenics	1	1	1h30			10 h30	2 h30		100%
Transversal EU Code: UET 3.2 Credits: 1 Coefficients: 1	Professional Project and Business Management	1	1	1h30			10 h30	2 h30	100%	
Total semester 6		**30**	**17**	**12h**	**6h.**	**7h**	**375 hours**	**375 hours**		

The assessment methods presented in these tables are given for information purposes only; the establishment's training team may suggest

Overall training summary:

EU / VH	UEF	EMU	UED	UET	Total
Course	720h00	120h00	225h00	6:00 p.m.	1245h00
TD	495h00	10:30 p.m.	---	---	5:17 p.m.
TP	---	487h30	---	---	487h30
Personal work	1485h00	720h00	25h00	8:00 p.m.	2250h00
Other (specify)	---	---	---	---	---
Total	2700h00	1350h00	250h00	8:00 p.m.	4500h00
Credits	108	54	10	8	180
% in credits for each EU	60%	30%	10%		100%





III - Detailed program by subject

Semester: 1
Teaching unit: UEF1.1
Subject 1: Mathematics 1
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

This first mathematics subject is particularly dedicated to standardizing the level of students entering university. The first new elements are taught progressively in order to lead students towards more advanced mathematics. The concepts covered in this subject are fundamental and among the most used in the field of Science and Technology.

Recommended prior knowledge

Basics of Mathematicsfinal year classes(sets, functions, equations, etc.).

Content of the material:

Chapter 1.Methods of mathematical reasoning (1 Week)

1-1 Direct reasoning. 1-2 Reasoning by contraposition. 1-3 Reasoning by contradiction. 1-4 Reasoning by counterexample. 1-5 Reasoning by recurrence.

Chapter 2.Sets, relations and applications (2 Weeks)

2.1 Set theory. 2-2 Order relations, Equivalence relations. 2-3 Injective, surjective, bijective applications: definition of an application, direct image, reciprocal image, characteristic of an application.

Chapter 3. Real functions with one real variable (3 Weeks)

3-1 Limit, continuity of a function. 3-2 Derivative and differentiability of a function.

Chapter 4. Application to elementary functions (3 Weeks)

4-1 Power Function. 4-2 Logarithmic Function. 4-3 Exponential Function. 4-4 Hyperbolic Function. 4-5 Trigonometric Function. 4-6 Inverse Function

Chapter 5. Limited development (2 Weeks)

5-1 Taylor's formula. 5-2 Limited development. 5-3 Applications.

Chapter 6. Linear algebra (4 Weeks)

6-1 Laws and internal composition. 6-2 Vector space, basis, dimension (definitions and elementary properties). 6-3 Linear application, kernel, image, rank.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- K. Allab, Elements of analysis, Function of a real variable, 1st & 2nd years of university, Office of University Publications.
2- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with Solutions, Vuibert.
3- N. Faddeev, I. Sominski, Collection of exercises in higher algebra, Moscow Edition
4- M. Balabne, M. Duflo, M. Frish, D. Guegan, Geometry – 2nd year of the 1st cycle preparatory classes, Vuibert University.
5- B. Calvo, J. Doyen, A. Calvo, F. Boshet, Algebra exercises, 1st scientific cycle preparation for the grandes écoles 2nd year, Armand Colin – Collection U.
6- J. Quinet, Elementary course in higher mathematics 1- Algebra, Dunod.
7- J. Quinet, Elementary course in higher mathematics 2- Usual functions, Dunod.
8- J. Quinet, Elementary course in higher mathematics 3- Integral calculus and series, Dunod.
9- J. Quinet, Elementary course in higher mathematics 4- Differential equations, Dunod.

Semester: 1
Teaching unit: UEF 1.1
Subject 2: Physics 1
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

Introduce the student to the basics of Newtonian physics through three main parts: Kinematics, Dynamics and Work and Energy.

Recommended prior knowledge

Notions of mathematics and physics.

Content of the material:

Mathematical reminders (2 Weeks)

1- The dimensional equations

2-Vector calculus: scalar product (norm), vector product, multivariate functions, derivation. Vector analysis: gradient, rotational operators, etc.

Chapter 1. Kinematic (5 Weeks)

1- Position vector in coordinate systems (Cartesian, cylindrical, spherical, curvilinear) - law of motion - Trajectory. 2- Velocity and acceleration in coordinate systems. 3- Applications: Movement of the material point in different coordinate systems. 4- Relative movement.

Chapter 2. Dynamic: (4 Weeks)

1- General: Mass - Force - Moment of force - Absolute and Galilean reference frame. 2- Newton's laws. 3- Principle of conservation of momentum. 4- Differential equation of motion. 5- Angular momentum. 6- Applications of the fundamental law for forces (constant, time-dependent, speed-dependent, central force, etc.).

Chapter 3.Work and energy (4 Weeks)

1- Work of a force. 2- Kinetic energy. 3- Potential energy – Examples of potential energy (gravity, gravitational, elastic). 4- Conservative and non-conservative forces - Total energy theorem.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. HAS. Gibaud,Mr. Henry;Physics course - Point mechanics - Course and corrected exercises;Dunod, 2007.
2. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd Ed.; 2005.
3. PA Tipler, G. Mosca; Physics For Scientists and Engineers, 6th Ed., WH Freeman Company, 2008.

Semester: 1
Teaching unit: UEF1.1
Subject 3: Structure of matter
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

The teaching of this subject allows the student to acquire the basic formalisms in chemistry, particularly within the subject describing the atom and the chemical bond, the chemical elements and the periodic table with energy quantification.Making students better able to solve chemistry problems.

Recommended prior knowledge

Basic concepts of mathematics and general chemistry.

Content of the material:

Chapter 1:Basic concepts (2 Weeks)

Macroscopic states and characteristics of the states of matter, changes in states of matter, concepts of atom, molecule, mole and Avogadro's number, atomic mass unit, atomic and molecular molar mass, molar volume, Law of mass: Conservation of mass (Lavoisier), chemical reaction, Qualitative aspect of matter, Quantitative aspect of matter.

Chapter 2:Main constituents of matter (3 Weeks)

Introduction: Faraday's Experiment: Relationship between Matter and Electricity**,**Highlighting the constituents of matter and therefore of the atom and**,**some physical properties (mass and charge), Rutherford planetary model, Presentation and characteristics of the atom (Symbol, atomic number Z, mass number A, number of protons, neutrons and electrons), Isotopy and relative abundance of different isotopes, Separation of isotopes and determination of the atomic mass and the average mass of an atom: Mass spectrometry: Bainbridge spectrograph, Binding and cohesion energy of nuclei, Stability of nuclei.

Chapter 3: Radioactivity – Nuclear Reactions (2 Weeks)

Natural radioactivity (radiationalpha,βAndγ), Artificial radioactivity and nuclear reactions, Kinetics of radioactive decay, Applications of radioactivity.

Chapter 4:Electronic structure of the atom (2 Weeks)

Wave-particle duality, Interaction between light and matter, Bohr's atomic model: hydrogen atom, The hydrogen atom in wave mechanics, Polyelectronic atoms in wave mechanics.

Chapter 5:Periodic table of elements (3 Weeks)

D. Mendeleev's Periodic Classification, Modern Periodic Classification, Evolution and periodicity of physicochemical properties of elements, Calculation of radii (atomic and ionic), successive ionization energies, electron affinity and electronegativity (Mulliken scale) by Slater's rules.

Chapter 6:Chemical bonds (3 Weeks)

Covalent bonding in Lewis theory, Polarized covalent bonding, dipole moment and partial ionic character of the bond, Geometry of molecules: Gillespie theory or VSEPR, Chemical bonding in the quantum model.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references

1. Ouahes, Devallez, General Chemistry, OPU.
2. SS Zumdhal & coll., General Chemistry, De Boeck University.
3. Y. Jean, Electronic structure of molecules: 1 from the atom to simple molecules, 3rd edition, Dunod, 2003.
4. F. Vassaux, Chemistry in IUT and BTS.

5. A. Casalot & A. Durupthy, Inorganic Chemistry 2nd cycle course, Hachette.
6. P. Arnaud, Course in Physical Chemistry, Ed. Dunod.
7. M. Guymont, Structure of matter, Belin Coll., 2003.
8. G. Devore, General Chemistry: T1, study of structures, Coll. Vuibert, 1980.
9. M. Karapetiantz, Constitution of Matter, Ed. Mir, 1980.

Semester: 1
Teaching unit: UEM 1.1
Subject 1: Physics 1 Practical Work
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives
Consolidate the theoretical knowledge provided in the course through a number of practical exercises.

Recommended prior knowledge
Notions of mathematics and physics.

Content of the material:

5 manipulations minimum (3 hours / 15 days):

- Methodology for presenting practical work reports and calculating errors.
- Verification of Newton's 2nd law
- Free fall
- Simple pendulum
- Elastic collisions
- Inelastic collisions
- Moment of inertia
- Centrifugal force

Assessment method:
Continuous assessment: 100%.

Semester: 1
Teaching unit: UEM1.1
Subject 2: Chemistry 1 Practical Work
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives

Consolidate the theoretical knowledge provided during the structure of matter course through a number of practical exercises.

Recommended prior knowledge

Basic Chemistry Concepts.

Content of the material:

1.Safety in the laboratory

2.Preparation of solutions

3. Notions on uncertainty calculations applied to chemistry.

4. Acid-base dosage by colorimetry and pH-metry.

5. Acid-base dosage by conductivity meter.

5. Oxidation-reduction assay

6. Determination of water hardness

7. Determination of ions in water: determination of chloride ions by the Mohr method.

Assessment method:

Continuous assessment: 100%

Semester: 1
Teaching unit: UEM1.1
Subject 3: Computer Science 1
VHS: 45h00 (Lecture: 1h30, Practical work: 1h30)
Credits: 4
Coefficient: 2

Objective and recommendations:
The objective of the subject is to enable students to learn to program using a high-level language (Fortran, Pascal, or C). The choice of language is left to the discretion of each institution. The concept of algorithms must be implicitly addressed during language learning.

Recommended prior knowledge
Basic concepts of web technology.

Content of the material:

Part 1. Introduction to Computer Science (5 Weeks)
1- Definition of computing
2- Evolution of computing and computers
3- Information coding systems
4- Operating principle of a computer
5- Hardware part of a computer
6- System part
Basic systems (operating systems (Windows, Linux, Mac OS, ...)
Programming languages, application software

Part 2. Concepts of algorithm and program (10Weeks)
1- Concept of an algorithm
2- Organizational chart representation
3- Structure of a program
4- The approach and analysis of a problem
5- Data structure: Constants and variables, Data types
6- Operators: assignment operator, relational operators, logical operators, arithmetic operations, priorities in operations
7- Input/output operations
8- Control structures: Conditional control structures, Repetitive control structures

Computer Science 1:
The practical exercises are intended to illustrate the concepts taught during the course. These exercises should begin with the lessons according to the following schedule:
•Introductory and advanced practical workfamiliarization with the computer machine from a hardware and operating system point of view (exploration of the different functionalities of the OS)
•Practical work on the use of a programming environment (Editing, Assembly, Compilation, etc.)
• TPapplication of programming techniques seen in class.

Assessment method:
Continuous assessment: 40%; Exam: 60%.

Bibliographic references
1- John Paul Mueller and Luca Massaron, Algorithms for Dummies large format, 2017.
2- Charles E. Leiserson, Clifford Stein and Thomas H. Cormen, Algorithmics: course with 957 exercises and 158 problems, 2017.
3- Thomas H. Cormen, Algorithms: Basic Notions, 2013.

Semester: 1

Teaching unit: UEM1.1
Subject 4: Writing Methodology
VHS: 3:00 p.m. (Class: 1 hour)
Credits: 1
Coefficient: 1

Teaching objectives

To familiarize and train students with current concepts of writing methodology in force in the Science and Technology profession. Among the skills to be acquired: Knowing how to present oneself; Knowing how to write a CV and a cover letter; Knowing how to position oneself in writing or orally in relation to an opinion or an idea; Mastering syntax and spelling in writing.

Recommended prior knowledge

Basic French.Basic principle of writing a document.

Content of the material:

Chapter 1. Concepts and generalities on writing techniques (2 Weeks)
- Definitions, standards
-Applications: writing a summary, a letter, a request

Chapter 2. Information research, synthesis and exploitation (3 Weeks)
-Searching for information in the library (Paper format: Books, Magazines)
-Searching for information on the Internet (Digital: Databases; Search engines, etc.).
-Applications

Chapter 3 Techniques and procedures of writing (3 Weeks)
-Basic Principles of Writing - Punctuation, Syntax, Sentences
-The length of sentences
-Division into paragraphs
-Using a neutral style and writing in the third person
-Readability
-Objectivity
-Intellectual rigor and plagiarism

Chapter 4 Writing a Report (4 Weeks)
Cover pages, Summary, Introduction, Method, Results, Discussion, Conclusion, Bibliography, Appendices, Summary and Keywords

Chapter 5. Applications (3 Weeks)
Report of a practical work

Assessment method:

Control Exam: 100%.

Bibliographic references:

1. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
2. M. Fayet, Successful Reporting, 3rd edition, Eyrolles, 2009.
3. M. Kalika, Master's thesis - Managing a thesis, Writing a report, Preparing a defense, Dunod, 2016.
4. M. Greuter, Succeeding in your dissertation and internship report, l'Etudiant, 2014
5. F. Cartier, Written and oral communication, Edition GEP- Groupe Eyrolles, 2012.
6. M. Fayet, Methods of written and oral communication, 3rd edition, Dunod, 2008.
7. E. Riondet, P. Lenormand, The big book of letter models, Eyrolles, 2012.

8. R. Barrass, Scientist must write – A guide to better writing for scientists, engineers and students, 2d edition, Routledge, 2002.
9. G. Andreani, The Practice of Correspondence, Hachette, 1995.
10. Ph. Rubens, Science & Technical Writing, A Manual of Style, 2d edition, Routledge, 2001.
11. A. Wallwork, User Guides, Manuals, and Technical Writing – A Guide to Professional English, Springer, 2014.

Semester: 1
Teaching unit: UED1.1
Subject 1: Careers in Science and Technology 1
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Objective of the subject:
To introduce the student, in a first step, to all the sectors covered by the Science and Technology Field and in a second step to a range of careers that these sectors lead to. In the same context, this subject introduces the new challenges of sustainable development as well as the new careers that can result from it.

Recommended prior knowledge
None.

Content of the subject:
1.What is engineering science? **(2 weeks)**
The engineering profession, history and challenges of the 21st century, Search for a profession/recruitment advertisement by keyword, develop a simple job description (job title, company, main activities, skills required (knowledge, know-how, interpersonal skills)

2.Electronics, Telecommunications, Biomedical Engineering, Electrotechnics, Electromechanics, Optics & Precision Mechanics: **(2 weeks)**
- Definitions, areas of application (Home automation,embedded applications for automobiles,Video surveillance, Mobile telephony, Optical fiber, Advanced scientific instrumentation, Imagingand Instrumentationmedical, Giant mirrors, Contact lenses, Transport and distribution of electrical energy, Power generation plants, Energy efficiency,Maintenance of industrial equipment,Elevators, Wind Turbines, …
- Role of the specialist in these areas.

3.Automation and Industrial Engineering sectors: **(1 week)**
- Definitions, areas of application (Automated industrial chains, Numerical Control Machine Tools, Robotics, Inventory Management, Goods Traffic Management, Quality, - Role of the specialist in these areas.

4.Process Engineering, Hydrocarbons and Petrochemical Industries:
(2 weeks)
- Definitions, Pharmaceutical industry, Food industry,Leather and textile industry,Biotechnologies, Chemical and petrochemical industry,Plastics industry,Energy sector (oil, gas), …
- Role of the specialist in these areas.

5. Sustainable development (SD): **(4 weeks)**
Definitions, Global issues (climate change, demographic transitions, resource depletion (oil, gas, coal, etc.), biodiversity loss, etc.), SD diagram (Sustainable = Viable + Livable + Equitable), SD actors (governments, citizens, socio-economic sector, international organizations, etc.), Global nature of SD challenges

6. Sustainable engineering: **(4 weeks)**
Definition, Principles of sustainable engineering (definitions of: sustainable energy/energy efficiency, sustainable mobility/ecomobility, resource recovery (water, metals and minerals, etc.), sustainable production), Relevance of sustainable engineering in S&T sectors, Relationship between sustainability and engineering, Responsibility of engineers in the implementation of sustainable projects, etc.

Student's personal work for this subject:
The teacher in charge of this subject can let his students know that he can always assess them by asking them to prepare job sheets. Ask the students to watch a popular science film at home related to the chosen job (after giving them either the film electronically or giving them the internet link to this film) and then ask them to submit a written report or make an oral presentation of the summary of this film, etc. The improvement of these activities is left to the discretion of the teacher and the training team whoare the only ones able to define the best way to take this personal work into account inthe overall grade of the final exam.

Group work: Development of job descriptions for professions in each sector based on recruitment advertisements found on application sitesjob (eg http://www.onisep.fr/Decouvrir-les-metiers,www.indeed.fr, www.pole-emploi.fr)(1 sector / group).
Depending on the capacity of the establishments, recommend calling on doctoral students and former graduates of the establishment in a tutoring/mentoring system where each group can call on its tutor/mentor to develop the job description/discover the different ST professions.

Assessment method:
100% exam

Bibliographic references:
1- What jobs for tomorrow? Publisher: ONISEP, 2016, Collection: Les Dossiers.
2- J. Douënel and I. Sédès, Choosing a career according to your profile, Editions d'Organisation, Collection: Employment & career, 2010.
3- V. Bertereau and E. Ratière, What Job Are You Made For? Publisher: L'Étudiant, 6th edition, Collection: Métiers, 2015.
4- The great book of professions, Publisher: L'Étudiant, Collection: Métiers, 2017.
5- Careers in the aeronautics and space industry, Collection: Parcours, Edition: ONISEP, 2017.
6- Careers in electronics and robotics, Collection: Parcours, Edition: ONISEP, 2015.
7- Environmental and sustainable development professions, Collection: Parcours, Edition: ONISEP, 2015.
8- Construction and public works trades, Collection: Parcours, Edition: ONISEP, 2016.
9- Transport and logistics professions, Collection: Parcours, Edition: ONISEP, 2016.
10- Energy professions, Collection: Parcours, Edition: ONISEP, 2016.
11- Mechanical professions, Collection: Parcours, Edition: ONISEP, 2014.
12- Careers in chemistry, Collection: Parcours, Edition: ONISEP, 2017.
13- Web professions, Collection: Parcours, Edition: ONISEP, 2015.
14- Careers in biology, Collection: Parcours, Edition: ONISEP, 2016.

Semester: 1
Teaching unit: UET1.1
Subject 1: French language1
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:
This subject aims to develop the following four skills: Oral comprehension, Written comprehension, Oral expression and Written expression through reading and studying texts.

Recommended prior knowledge:
Basic French.

Content of the material:
Below we offer a set of themes that cover fundamental sciences, technologies, economics, social issues, communication, sports, health, etc. The teacher can choose texts from this list to develop them during the course. Otherwise, they are free to address other themes of their choice. The texts can be borrowed from various communication media: daily newspapers, sports or entertainment magazines, specialized or popular magazines, books, websites, audio and video recordings, etc.
For each text, the teacher helps the student develop their linguistic skills: listening, comprehension, and oral and written expression. In addition, they must use this text to identify the grammatical structures they will develop during the same class session. Here, for illustration purposes, we recall a set of grammatical structures that can be developed as examples. Of course, it is not a question of developing them all or in the same way. Some can be recalled and others in great detail.

Examples of themes	Grammatical structures
Climate change Pollution The electric car The robots Artificial intelligence The Nobel Prize The Olympic Games Sports at school The Sahara The currency Assembly line work Ecology Nanotechnologies Optical fiber The engineering profession The power plant Energy efficiency The smart building Wind energy Solar energy	Punctuation. Proper nouns, Articles. Grammatical functions: The noun, The verb, The pronouns, The adjective, The adverb. The complement pronoun ''le, la, les, lui, leur, y, en, me, te, …'' The agreements. The negative sentence. Don't…, Don't… yet, Don't… anymore, Don't… ever, Don't… point, … The interrogative sentence. Question with "Who, What, What", Question with "When, Where, How much, Why, How, Which, Which". The exclamatory sentence. Reflexive verbs. Impersonal verbs. The indicative tenses: Present, Future, Past Perfect, Simple Past, Imperfect. …

Assessment method:
Review: 100%.

Bibliographic references:

1. M. Badefort, Objective: International French Test, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Passing the TCF, Exercises and training activities, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Progressive French Grammar with 400 exercises, Advanced Level, CLE International.
4. Collective, Besherelles: Grammar for all, Hatier.
5. Collective, Besherelles: Conjugation for all, Hatier.
6. Mr. Grégoire, Progressive French Grammar with 400 exercises, Beginner Level, CLE International, 1997.
7. A. Hasni et al., Training in teaching science and technology in secondary schools, Presses de l'université du Québec, 2006.
8. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
9. JM Robert, Difficulties of French, Hachette,
10. C. Tisset, Teaching French at school: Grammar, Spelling and Conjugation, Hachette Education, 2005.
11. J. Bossé-Andrieu, Summary of the Rules of Grammar and Spelling, Presses of the University of Quebec, 2001.
12. J.-P. Colin, French simply, Eyrolles, 2010.
13. Collective, French Assessment Test, Hachette, 2001.
14. Y. Delatour et al., Practical French grammar in 80 cards with corrected exercises, Hachette, 2000.
15. Ch. Descotes et al., The Exerciser: French Expression for Intermediate Level, Presses Universitaires de Grenoble, 1993.
16. H. Jaraush, C. Tufts, Sur le Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al, The Essentials – Spelling, Larousse, 2009.

Semester: 1
Teaching unit: UET1.1
Subject 1: English Language1
VHS: 10:30 p.m. (Class: 1.5 hours)
Credit: 1
Coefficient: 1

Objective:
Develop the reading, writing, listening and speaking abilities of the students.

Recommended prior knowledge:
Basic English.

Contents:
The English syllabus consists of a set of texts containing scientific and technical parts. The chosen texts must be used to study scientific and technical English and Grammar acquisition.
The texts must be selected according to the vocabulary built up, familiarization with both scientific and matters in English for further understanding. Therefore, each text will be defined by a set of vocabulary concepts, a set of special sentences (idioms) and comprehension questions.
The texts must also contain a terminology which means the translation of some words from English to French one. , the activity at the end of each session must include a translation of long statements which are selected from the texts.

Examples for some lectures:	Examples of Word Study: Patterns
Iron and Steel	Make + Noun + Adjective
Heat Treatment of Steel.	Quantity, Contents
Lubrication of Bearings.	Enable, Allow, Make, etc. + Infinitive
The Lathe.	Comparative, Maximum and Minimum
Welding.	The Use of Will, Can and May
Steam Boilers.	Prevention, Protection, etc., Classification
Steam Locomotives.	The Impersonal Passive
Condensation and Condensers.	Passive Verb + By + Noun (agent)
Centrifugal Governors.	Too Much or Too Little
Impulse Turbines.	Instructions (Imperative)
The Petro Engine.	Requirements and Necessity
The Carburetion System.	Means (by + Noun or –ing)
The Jet Engine.	Time Statements
The Turbo-Prop Engine.	Function, Duty
Aerofoil.	Alternatives

Mode evaluation:
Exam: 100%.

References:

1. J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office of University Publications, 1994.
2. AJ Herbert, The Structure of Technical English, Longman, 1972.
3. S. Berland-Delepine, Methodical Grammar of Modern English with Exercises, Ophrys, 1982.
4. Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.
5. R. Fowler, The Little, Brown Handbook, Little, Brown Company, 1980.

6. Cambridge – First Certificate in English, Cambridge books, 2008.
7. K. Wilson, Th. Healy, First Choice, Oxford, 2007.
8. M. Mann, S. Tayore-Knowles, Destination: Grammar & Vocabulary with Answer Key, MacMillan, 2006.
9. E. Hamby, Ph. Bedford Robinson, Special English Computer Applications, Cassell, 1980.
10. P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.
11. Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.
12. Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.
13. Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.
14. Claude Renucci, English: 1000 Words and Expressions from the Press: Vocabulary and Expressions from the Economic, Social and Political World, Fernand Nathan, 2006.

Semester: 2
Teaching unit: UEF1.2
Subject 1: Mathematics 2
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

Students are led, step by step, towards understanding mathematics useful for their university studies. At the end of the course, the student should be able to: solve first and second degree differential equations; solve integrals of rational, exponential, trigonometric and polynomial functions; solve systems of linear equations using several methods.

Recommended prior knowledge

Basic concepts of mathematics (differential equation, integrals, systems of equations, etc.)

Content of the material:

Chapter 1: Matrices and Determinants (3 Weeks)
1-1 Matrices (Definition, operation). 1-2 Matrix associated with a linear application. 1-3 Linear application associated with a matrix. 1-4 Change of basis, passage matrix.

Chapter 2: Systems of Linear Equations (2 Weeks)
2-1 Generalities. 2-2 Study of the solution set. 2-3 Methods for solving a linear system. Resolution by the Cramer method. Resolution by the inverse matrix method. Resolution by the Gauss method.

Chapter 3: Integrals (4 Weeks)
3-1Indefinite integral, property.3-2Integration of rational functions.3-3Integration of exponential and trigonometric functions.3-4The integral of polynomials.3-5Defined integration

Chapter 4: Differential Equations (4 Weeks)
4-1 Ordinary differential equations. 4-2 First-order differential equations. 4-3 Second-order differential equations. 4-4 Second-order ordinary differential equations with constant coefficient.

Chapter 5: Functions of Several Variables (2 Weeks)
5-1 Limit, continuity and partial derivatives of a function. 5-2 Differentiability. 5-3 Double and triple integrals.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 corrected exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 corrected exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.
4- M. Krasnov, Collection of problems on ordinary differential equations, Moscow Edition
11- N. Faddeev, I. Sominski, Collection of exercises in higher algebra, Moscow Edition.

Semester: 2
Teaching unit: UEF 1.2

Subject 2: Physics 2
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

To introduce the student to the physical phenomena underlying the laws of electricity in general.

Recommended prior knowledge

Mathematics 1, Physics 1.

Content of the material:

Mathematical reminders: (1 Week)

1- Elements of length, surface, volume in Cartesian, cylindrical, spherical coordinate systems. Solid angle,Operators (gradient, rotational, Nabla, Laplacian and divergence).
2- Multiple derivatives and integrals.

Chapter I. Electrostatics: (6 Weeks)

1- Electrostatic charges and fields.Electrostatic interaction force-Coulomb's law.
2- Electrostatic potential. 3- Electric dipole. 4- Electric field flux. 5- Gauss's theorem. 6- Conductors in equilibrium. 7- Electrostatic pressure. 8- Capacitance of a conductor and a capacitor.

Chapter II. Electrokinetics: (4 Weeks)

1- Electrical conductor. 2- Ohm's law. 3- Joule's law. 4- Electrical circuits. 5- Application of Ohm's law to networks. 6- Kirchhoff's laws. Thevenin's theorem.

Chapter III. Electromagnetism: (4 Weeks)

1- Magnetic field: Definition of a magnetic field,Biot and Savart's Law, Ampere's Theorem, Calculation of magnetic fields created by permanent currents.
2- Induction phenomena: Induction phenomena (circuit in a variable magnetic field and mobile circuit in a magnetic fieldpermanent), FLorentz force,FLaplace force, Faraday's law, Lenz's law, Application to coupled circuits.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. J.-P. Perez, R. Carles, R. Fleckinger; Electromagnetism Foundations and Applications, Ed. Dunod, 2011.
2. H. Djelouah; Electromagnetism; Office of University Publications, 2011.
3. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd ed. ; 2005.
4. PA Tipler, G. Mosca; Physics For Scientists and Engineers, 6th ed., WH Freeman Company, 2008.

Semester: 2
Teaching unit: UEF1.2
Subject 3: Thermodynamics
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

Provide the necessary foundations of classical thermodynamics for applications to combustion and thermal machines. Homogenize students' knowledge. The skills to be acquired are: The acquisition of a scientific basis of classical thermodynamics; The application of thermodynamics to various systems; The statement, explanation and understanding of the fundamental principles of thermodynamics.

Recommended prior knowledge

Basic mathematics.

Content of the material:

Chapter 1: Generalities on thermodynamics (3 Weeks)

1-Fundamental properties of state functions. 2- Definitions of thermodynamic systems and the external environment. 3- Description of a thermodynamic system. 4- Evolution and thermodynamic equilibrium states of a system. 5- Possible transfers between the system and the external environment. 6- Transformations of the state of a system (operation, evolution). 7- Reminders of the laws of ideal gases.

Chapter 2: The 1st principle of thermodynamics: (3 weeks)

1. Work, heat, internal energy, concept of conservation of energy. 2. The first principle of thermodynamics: statement, concept of internal energy of a system, application to ideal gas, enthalpy function, heat capacity, reversible transformations (isochoric, isobaric, isothermal, adiabatic).

Chapter 3: Applications of the first principle of thermodynamics to thermochemistry (3 weeks)

Heats of reaction, standard state, Lstandard enthalpy of formation, enthalpy of dissociation, Lenthalpy of change of physical state, enthalpy of a chemical reaction, Hess's law, Kirchoff's law.

Chapter 4: The 2nd principle of thermodynamics (3 weeks)

1- The 2nd principle for a closed system. 2. Statement of the 2nd principle: Entropy of a closed isolated system. 3. Calculation of the variation of entropy: reversible isothermal transformation, reversible isochoric transformation, reversible isobaric transformation, adiabatic transformation, during a change of state, during a chemical reaction.

Chapter 5: The 3rd Principle and absolute entropy **(1 week)**

Chapter 6: Free energy and enthalpy – Criteria for the evolution of a system (2 weeks)

1- Introduction. 2- Free energy and enthalpy. 3- Chemical equilibria

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. C. Coulon, S. Le Boiteux S. and P. Segonds, Thermodynamics Physics - Course and exercises with solutions, Dunod Edition.
2. HB Callen, Thermodynamics, Course, Edition John Wiley and Sons, 1960
3. R. Clerac, C. Coulon, P. Goyer, S. Le Boiteux & C. Rivenc, Thermodynamics, Courses and tutorials in thermodynamics, University of Bordeaux 1, 2003
4. O. Perrot, Thermodynamics Course IUT of Saint-Omer Dunkirk, 2011

5. CL Huillier, J. Rous, Introduction to thermodynamics, Dunod Edition.

Semester: 2
Teaching unit: UEM 1.2
Subject 1: Physics 2 Practical Work
VHS: 45h00 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

Consolidate through practical work sessions the theoretical concepts covered in the Physics 2 course.

Recommended prior knowledge

Mathematics 1, Physics 1.

Content of the material:

5 manipulations minimum (3h00 / 15 days)

- Presentation of measuring instruments and tools (Voltmeter, Ammeter, Rheostat, Oscilloscopes, Generator, etc.).
- Kirchhoff's laws (mesh law, knot law).
- Thévenin's theorem.
- Association and Measurement of inductances and capacities
- Charging and discharging a capacitor
- Oscilloscope
- Practical work on magnetism

Assessment method:

Continuous assessment: 100%

Semester: 2
Teaching unit: UEM1.2
Subject 2: Chemistry 2 Practical Work
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives

Consolidate the theoretical concepts covered in the Thermodynamics course through practical work sessions.

Recommended prior knowledge

Thermodynamics.

Content of the material:

1. Ideal gas laws.
2. Water value of the calorimeter.
3. Specific heat: specific heat of liquid and solid bodies.
4. Latent heat: Latent heat of fusion of ice
5.Heat of reaction: Determination of the energy released by a chemical reaction (HCl/NaOH)
6. Hess's Law
7. Vapor pressure of a solution.

Assessment method:

Continuous assessment: 100%

Semester: 2
Teaching unit: UEM1.2
Subject 3: Computer Science 2
VHS: 45h00 (Lecture: 1h30, Practical work: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

Master basic programming and algorithmic techniques. Acquire fundamental computer science concepts. The skills to be acquired are: Programming with a certain degree of autonomy; Designing algorithms from the simplest to the relatively complex.

Recommended prior knowledge

Know how to use the university website, file systems, Windows user interface, programming environment.

Content of the material:

Chapter 1:Indexed variables (4Weeks)
1- One-dimensional arrays: Representation in memory, Operations on arrays
2- Two-dimensional arrays: Representation in memory, Operations on two-dimensional arrays

Chapter 2: Functions and Procedures (6 Weeks)
1- Functions: Types of functions, declaration of functions, function calls
2- Procedures: Concepts of global variables and local variables, simple procedure, procedure with arguments

Chapter 3: Recordings and Files(5 Weeks)
1- Heterogeneous data structure
2- Structure of a record (notion of fields)
3- Manipulation of record structures
4- Concept of file
5- File access modes
6- Reading and writing to a file

Computer Science 2:

Plan a certain number of practical exercises to put into practice the programming techniques seen during the course.
- TPapplication of programming techniques seen in class.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- Algorithms for Dummies large format Book by John Paul Mueller (Informatiker, USA) and Luca Massaron 2017
2- Algorithmics: course with 957 exercises and 158 problems Book by Charles E. Leiserson, Clifford Stein and Thomas H. Cormen 2017
3- Algorithms: Basic Notions Book by Thomas H. Cormen 2013.

Semester: 2
Teaching unit: UEM1.2
Subject 4: Presentation Methodology
VHS: 3:00 p.m. (Class: 1 hour)
Credits: 1
Coefficient: 1

Teaching objectives

Provide the main bases for a successful oral presentation.Among the skills to acquire: Knowing how to prepare a presentation; Knowing how to present a presentation; Knowing how to capture the attention of the audience; Being aware of the pitfalls of plagiarism and knowing the regulations of intellectual property.

Recommended prior knowledge

Expression and communication techniques and writing methodology.

Content of the material:

Chapter 1: The Oral Presentation (3 Weeks)
Communication. Preparing an oral presentation. Different types of plans.

Chapter 2: Presenting an Oral Presentation (3 Weeks)
Structure of an oral presentation. Presentation of an oral presentation.

Chapter 3: Plagiarism and Intellectual Property (3 Weeks)
1- Plagiarism: Definitions of plagiarism, punishment for plagiarism, how to borrow other authors' work, quotes, illustrations, how to be sure to avoid plagiarism?
2- Writing a bibliography: Definition, objectives, how to present a bibliography, writing the bibliography

Chapter 4: Presenting Written Work (6 Weeks)
- Present a written work. Applications: presentation of an oral presentation.

Assessment method:

Review: 100%.

Bibliographic references:

1. M. Fayet, Methods of written and oral communication, 3rd edition, Dunod, 2008.
2. M. Kalika, Master's thesis – Managing a thesis, Writing a report, Preparing a defense, Dunod, 2016.
3. M. Greuter, Succeeding in your dissertation and internship report, l'Etudiant, 2014
4. B. Grange, Making a Successful Presentation. Preparing Powerful Slides and Communicating Effectively in Public. Eyrolles, 2009.
5. H. Biju-Duval, C. Delhay, All speakers, Eyrolles, 2011.
6. C. Eberhardt, Practical work with PowerPoint. Creating and laying out slides, Dunod, 2014.
7. F. Cartier, Written and oral communication, Edition GEP- Groupe Eyrolles, 2012.
8. L. Levasseur, 50 exercises for public speaking, Eyrolles, 2009.
9. S. Goodlad, Speaking technically – A Handbook for Scientists, Engineers, and Physicians on How to Improve Technical Presentations, Imperial College Press, 2000.
10. M. Markel, Technical communication, eleventh edition, Bedford/St Martin's, 2015.

Semester: 2
Teaching unit: UED1.2
Subject 1: Careers in Science and Technology 2
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Objective of the subject:
To introduce the student, in a first step, to all the sectors covered by the Science and Technology Field and in a second step to a range of careers that these sectors lead to. In the same context, this subject introduces the student to the new challenges of sustainable development as well as the new careers that can result from it.

Recommended prior knowledge
None.

Content of the subject:
1.Industrial Hygiene and Safety (IHS) sectorsand Gmining industry: (2 weeks)
- Definitions andareas of application (Safety of property and people, Environmental issues, Exploration and exploitation of mineral resources, etc.)
-Role of the specialist in these areas.

2.Climate Engineering and Transportation Engineering courses: **(2 weeks)**
- Definitions, areas of application (Air conditioning, Smart buildings,Safety in transport, traffic management and road, air, naval transport, etc.)
- Role of the specialist in these areas.

3.Civil Engineering, Hydraulics and Public Works sectors: **(2 weeks)**
- Definitions and areas of application (Construction materials, Major road and rail infrastructure, Bridges, Airports, Dams, Drinking water supply and sanitation, Hydraulic flows, Water resource management, Public works and land use planning, Smart cities, etc.)
- Role of the specialist in these areas.

4.Aeronautics, Mechanical Engineering, Maritime Engineering and Metallurgy: (2 weeks)
- Definitions and areas of application (Aeronautics, Avionics, Automotive Industry, Ports, Seawalls,Production of industrial equipment,Steel industry,Metal processing,…)
- Role of the specialist in these areas.

5. Approaches to sustainable production: (2 weeks)
Industrial ecology, remanufacturing, ecodesign.

6. Measure the sustainability of a process/product/service: (2 weeks)
Environmental analysis, Life cycle analysis (LCA), Carbon footprint, case studies/applications.

7. Sustainable Development and Business: (3 weeks)
Definition of the company as an economic entity (notions of profit, costs, performance) and social entity (notion of corporate social responsibility), Impact of economic activities on the environment (examples), Challenges/benefits of sustainable development for the company, Means of engagement in a sustainable development approach (e.g. ISO 14001 certification, labeling (e.g. energy labeling, Ecolabel, Organic/AB Label, FSC Label, etc.), strategic sustainable development plan, Global Reporting Initiative (GRI)…), World rankings of the most sustainable companies (Dow Jones Sustainable Index,

Global 100, etc.), Company case studieshigh-performance/eco-responsible in the ST sectors (e.g. SIEMENS, Cisco, Henkel AG & Co, TOTAL, Peugeot, Eni SPA ...).

Student's personal work for this subject:

- Work in groups/pairs: Reading articles on sustainable development and/or reports from successful and sustainable companies and preparing summaries of the main actions undertaken in the field of sustainable development.

Examples of documents for reading and summarizing:

- Case of ONA and ENIEM: Kadri, Mouloud, 2009, Sustainable development, business and ISO 14001 certification, Market and organizations vol. 1 (No. 8), p. 201-215 (free online access:http://www.cairn.info/revue-marche-et-organizations-2009-1-page-201.htm)
- Mireille Chiroleu-Assouline. Sustainable development strategies for businesses. Ideas, The Review of Economic and Social Sciences, CNDP, 2006, pp. 32-39 (free online access:http://halshs.archives-ouvertes.fr/hal-00306217/document)
- Web page on environmental and societal commitments ofTOTAL:https://www.total.com/fr/engagement
- Innovationssustainable mobilityfrom the PSA group:http://www.rapportannuel.groupe-psa.com/rapport-2015/engagements/dessolutions-innovantes-pour-des-transports-durables/

Assessment method:

100% exam.

Bibliographic references:

1- V. Maymo and G. Murat, The Sustainable Development and CSR Toolbox - 53 tools and methods, Edition: Dunod, 2017.

2- P. Jacquemot and V. Bedin, The encyclopedic dictionary of sustainable development, Edition: Sciences Humaines, 2017.

3- Y. Veyret, J. Jalta and M. Hagnerelle, Sustainable development: All the issues in 12 lessons, Edition: Autrement, 2010.

4- L. Grisel and Ph. Osset, Life Cycle Analysis of a Product or Service: Applications and Practical Implementation, 2nd Edition: AFNOR, 2008.

5- Sh. Shaked, N. Jolliet-Gavin, P. Crettaz, M. Saadé-Sbeih and O. Jolliet, Life Cycle Analysis: Understanding and Carrying Out an Eco-Assessment, 3rd Edition: PPUR, 2017.

6- G. Pitron and H. Védrine, The rare metal war: The hidden face of the energy and digital transition, Edition: Liens qui libèrent, 2018.

7- Environmental and sustainable development professions, Collection: Parcours, Edition: ONISEP, 2015.

Semester: 2
Teaching unit: UET1.2
Subject 1: French language 2
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:
This subject aims to develop the following four skills: Oral comprehension, Written comprehension, Oral expression and Written expression through reading and studying texts.

Recommended prior knowledge:
Basic French.

Content of the material:
Below we offer a set of themes that cover fundamental sciences, technologies, economics, social issues, communication, sports, health, etc. The teacher can choose texts from this list to develop them during the course. Otherwise, they are free to address other themes of their choice. The texts can be borrowed from various communication media: daily newspapers, sports or entertainment magazines, specialized or popular magazines, books, websites, audio and video recordings, etc.
For each text, the teacher helps the student develop their linguistic skills: listening, comprehension, and oral and written expression. In addition, they must use this text to identify the grammatical structures they will develop during the same class session. Here, for illustration purposes, we recall a set of grammatical structures that can be developed as examples. Of course, it is not a question of developing them all or in the same way. Some can be recalled and others in great detail.

Examples of themes	Grammatical structures
The pharmaceutical industry The food industry The National Employment Agency ANEM Sustainable development Renewable energies Biotechnology Stem cells Road safety The dams Water – Water resources Avionics Automotive electronics Electronic newspapers Carbon 14 dating Violence in stadiums Drugs: a social scourge Smoking School failure The Algerian War Social networks Advertising Autism	The subjunctive. The conditional. The imperative. The past participle. The passive form. Possessive adjectives, possessive pronouns. Demonstratives, Demonstrative pronouns. The expression of quantity (several, a few, enough, many, more, less, as much, etc.). Numbers and measurements. The pronouns "who, that, where, whose". Subordinate preposition of time. The cause, The consequence. The goal, the opposition, the condition. Comparatives, superlatives. …

Assessment method:
Review: 100%.

Bibliographic references:

1. M. Badefort, Objective: International French Test, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Passing the TCF, Exercises and training activities, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Progressive French Grammar with 400 exercises, Advanced Level, CLE International.
4. Collective, Besherelles: Grammar for all, Hatier.
5. Collective, Besherelles: Conjugation for all, Hatier.
6. Mr. Grégoire, Progressive French Grammar with 400 exercises, Beginner Level, CLE International, 1997.
7. A. Hasni et al., Training in teaching science and technology in secondary schools, Presses de l'université du Québec, 2006.
8. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
9. JM Robert, Difficulties of French, Hachette,
10. C. Tisset, Teaching French at school: Grammar, Spelling and Conjugation, Hachette Education, 2005.
11. J. Bossé-Andrieu, Summary of the Rules of Grammar and Spelling, Presses of the University of Quebec, 2001.
12. J.-P. Colin, French simply, Eyrolles, 2010.
13. Collective, French Assessment Test, Hachette, 2001.
14. Y. Delatour et al., Practical French Grammar in 80 cards with corrected exercises, Hachette, 2000.
15. Ch. Descotes et al., The Exerciser: French Expression for Intermediate Level, Presses Universitaires de Grenoble, 1993.
16. H. Jaraush, C. Tufts, Sur le Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al., The Essentials – Spelling, Larousse, 2009.

Semester: 2
Teaching unit: UET1.2
Subject 1: English Language 2
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Objective:
Develop the reading, writing, listening and speaking abilities of the students.

Recommended prior knowledge:
Basic English.

Contents:
The English syllabus consists of a set of texts containing scientific and technical parts. The chosen texts must be used to study scientific and technical English and Grammar acquisition.
The texts must be selected according to the vocabulary built up, familiarization with both scientific and matters in English for further understanding. Therefore, each text will be defined by a set of vocabulary concepts, a set of special sentences (idioms) and comprehension questions.
The texts must also contain a terminology which means the translation of some words from English to French one. , the activity at the end of each session must include a translation of long statements which are selected from the texts.

Examples for some lectures:	Examples of Word Study: Patterns
Radioactivity. Chain Reaction. Reactor Cooling System. Conductor and Conductivity. Induction Motors. Electrolysis. Liquid Flow and Metering. Liquid Pumps. Petroleum. Road Foundations. Rigid Pavements. Piles for Foundations. Suspension Bridges.	Explanation of Cause Result Conditions (if), Conditions (Restrictive) Eventuality Manner When, Once, If, etc. + Past Participle It is + Adjective + to Ace It is + Adjective or Verb + that… Similarity, Difference In Spite of, Although Formation of Adjectives Phrasal Verbs

Mode evaluation:
Exam: 100%.

References:

1. J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office of University Publications, 1994.
2. AJ Herbert, The Structure of Technical English, Longman, 1972.
3. S. Berland-Delepine, Methodical Grammar of Modern English with Exercises, Ophrys, 1982.
4. Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.
5. R. Fowler, The Little, Brown Handbook, Little, Brown Company, 1980.
6. Cambridge – First Certificate in English, Cambridge books, 2008.
7. K. Wilson, Th. Healy, First Choice, Oxford, 2007.
8. M. Mann, S. Tayore-Knowles, Destination: Grammar & Vocabulary with Answer Key, MacMillan, 2006.

9. E. Hamby, Ph. Bedford Robinson, Special English Computer Applications, Cassell, 1980.
10. P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.
11. Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.
12. Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.
13. Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.
14. Claude Renucci, English: 1000 Words and Expressions from the Press: Vocabulary and Expressions from the Economic, Social and Political World, Fernand Nathan, 2006.

Semester: 3
Teaching unit: UEF 2.1.1
Subject 1:Mathematics 3
VHS: 67h30 (Lecture: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

At the end of this course, the student should be able to know the different types of series and their conditions of convergence as well as the different types of convergence.

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Content of the subject:

Chapter 1: Simple and Multiple Integrals **3 weeks**
1.1 Reminders on the Riemann integral and on the calculation of primitives. 1.2 Double and triple integrals.
1.3 Application to the calculation of areas, volumes, etc.

Chapter 2: Improper Integrals **2 weeks**
2.1 Integrals of functions defined on an unbounded interval. 2.2 Integrals of functions defined on a bounded interval, infinite at one end.

Chapter 3: Differential Equations **2 weeks**
3.1 Review of ordinary differential equations. 3.2 Partial differential equations. 3.3 Special functions.

Chapter 4: Series **3 weeks**
4.1 Numerical series. 4.2 Sequences and series of functions. 4.3 Power series, Fourier series.

Chapter 5: Fourier Transform **3weeks**
5.1 Definition and properties. 5.2 Application to the resolution of differential equations.

Chapter 6: Laplace Transform **2weeks**
6.1 Definition and properties. 6.2 Application to the resolution of differential equations.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 corrected exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 corrected exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.
4- M. Krasnov, Collection of problems on ordinary differential equations, Moscow Edition
5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow Edition
6- J. Quinet, Elementary course in higher mathematics 3- Integral calculus and series, Dunod.
7- J. Quinet, Elementary course in higher mathematics 4- Differential equations, Dunod.
8- MR Spiegel, Laplace Transforms, Course and Problems, 450 Corrected Exercises, McGraw-Hill.

Semester: 3
Teaching unit: UEF 2.1.1
Subject 2: Waves and Vibrations
VHS: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

Introduce the student to the phenomena of mechanical vibrations restricted to low amplitude oscillations for 1 or 2 degrees of freedom as well as to the study of the propagation of mechanical waves.

Recommended prior knowledge

Mathematics 2, Physics 1 and Physics 2

Content of the material:

***Preamble**: This subject is divided into two parts, the Waves part and the Vibrations part, which can be approached independently of each other. In this regard and due to the consistency of this subject in terms of content, it is advisable to approach this subject in this order: Waves and then Vibrations for students in the Electrical Engineering (Group A) streams. While for students in Groups B and C (Civil Engineering, Mechanical Engineering and Process Engineering), it is advisable to start with Vibrations. In any case, the teacher is called upon to do his best to cover both parts. We remind you that this subject is intended for engineering professions in the Science and Technology field. Also, the teacher is requested to skim over all parts of the course that require demonstrations or theoretical developments and to focus only on the applied aspects. Moreover, demonstrations can be the subject of an auxiliary work to be requested from students as activities within the framework of the student's personal work. For this purpose, consult paragraph "G- Student Assessment through Continuous Assessment and Personal Work" present in this training offer.*

Part A: Vibrations

Chapter 1: Introduction to Lagrange's equations **2 weeks**

1.1 Lagrange equations for a particle
1.1.1 Lagrange equations
1.1.2 Case of conservative systems
1.1.3 Case of velocity-dependent friction forces
1.1.4 Case of a time-dependent external force
1.2 Multi-degree-of-freedom system.

Chapter 2: Free Oscillations of Systems at a Degree offreedom 2 weeks

2.1 Undamped Oscillations
2.2 Free oscillations of damped systems

Chapter 3: Forced Oscillations of One-Degree-of-Freedom Systems **1 week**

3.1 Differential equation
3.2 Mass-spring-damper system
3.3 Solution of the differential equation
3.3.1 Harmonic excitation
3.3.2 Periodic excitation
3.4 Mechanical impedance

Chapter 4: Free oscillations of two-degree-of-freedom systems **1 week**

4.1 Introduction
4.2 Two-degree-of-freedom systems

Chapter 5: Forced Oscillations of Two-Degree-of-Freedom Systems 2 weeks
5.1 Lagrange equations
5.2 Mass-spring-shock absorber system
5.3 Impedance
5.4 Applications
5.5 Generalization to systems with n degrees of freedom

Part B: Waves
Chapter 1: One-dimensional propagation phenomena 2 weeks
1.1 Generalities and basic definitions
1.2 Propagation equation
1.3 Solution of the propagation equation
1.4 Progressive sinusoidal wave
1.5 Superposition of two progressive sinusoidal waves

Chapter 2: Vibrating Strings 2 weeks
2.1 Wave equation
2.2 Harmonic Progressive Waves
2.3 Free oscillations of a string of finite length
2.4 Reflection and transmission

Chapter 3: Acoustic Waves in Fluids 1 week
3.1 Wave equation
3.2 Speed of sound
3.3 Progressive sinusoidal wave
3.4 Reflection-Transmission

Chapter 4: Electromagnetic Waves 2 weeks
4.1 Wave equation
4.2 Reflection-Transmission
4.3 Different types of electromagnetic waves

Assessment method:
Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. H. Djelouah; Vibrations and Mechanical Waves – Courses & Exercises (USTHB University website:perso.usthb.dz/~hdjelouah/Coursvom.html)
2. T. Becherrawy; Vibrations, waves and optics; Hermes science Lavoisier, 2010
3. J. Brac; Propagation of acoustic and elastic waves; Hermès science Publ. Lavoisier, 2003.
4. R. Lefort; Waves and Vibrations; Dunod, 2017
5. J. Bruneaux; Vibrations, waves; Ellipses, 2008.
6. J.-P. Perez, R. Carles, R. Fleckinger; Electromagnetism Foundations and Applications, Ed. Dunod, 2011.
5. H. Djelouah; Electromagnetism; Office of University Publications, 2011.

Semester: 3
Teaching unit: UEF 2.1.2
Subject 1:Fluid mechanics
VHS: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Objective of the teaching:

To introduce the student to the field of fluid mechanics, fluid statics will be detailed in the first part. Then in the second part the study of the movement of inviscid fluids will be considered at the end it is the movement of the real fluid that will be studied.

Recommended prior knowledge:

Content of the material:

Chapter 1: Properties of Fluids **3 weeks**

1. Physical definition of a fluid: States of matter, divided matter (dispersion, suspensions, emulsions)
2. Perfect fluid, real fluid, compressible fluid and incompressible fluid.
3. Density, volumetric mass
4. Rheology of a fluid, Viscosity of fluids, surface tension of a fluid

Chapter 2: Fluid Statics **4 weeks**

1. Definition of pressure, pressure at a point in a fluid
2. Fundamental law of fluid statics
3. Level surface
4. Pascal's Theorem
5. Calculation of pressure forces: Flat plate (horizontal, vertical, oblique), center of thrust, static pressure measuring instruments, pressure measurement atmospheric, barometer, Torricelli's law
2. Pressure for superimposed immiscible fluids

Chapter 3 Dynamics of perfect incompressible fluids **4 weeks**

1. Permanent flow
2. Continuity equation
3. Mass flow rate and volume flow rate
4. Bernoulli's theorem, cases without labor exchange and with labor exchange
5. Applications to flow and speed measurements: Venturi, Diaphragms, tubes of Pitot…
6. Euler's Theorem

Chapter 4: Dynamics of real incompressible fluids **4 weeks**

1. Flow regimes, Reynolds experiment
2. Dimensional analysis, Vashy-Buckingham theorem, Reynolds number
3. Linear pressure losses and singular pressure losses, Moody diagram.
4. Generalization of Bernoulli's theorem to real fluids

Assessment method: Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:
(Depending on the availability of documentation at the establishment level, websites, etc.)

1- Fundamentals of fluidmechanics 6th Edition, 2009,BR Munson, DF Young TH Okiishi, WW Huebsch6th Edition John Wiley & Sons
2- Fluid mechanics,YA Cengel- 2010 - Tata McGraw-Hill Education
3- Fluid Mechanics Frank M. White Fourth Edition 2003 McGraw-Hill
4- Fluid Mechanics and Hydraulics 2nd Edition, Ronald v. Giles, Jack B Evett, Cheng Liu, McGraw-Hill
5- S. Amirudin,JL Battaglia, 'Fluid Mechanics Course and Corrected Exercises' Ed. Dunod
6- R. Comolet, 'Experimental Fluid Mechanics', Volumes 1, 2 and 3, Ed. Masson et Cie.
7- R. Ouziaux, 'Applied Fluid Mechanics', Ed. Dunod, 1978
8- BR Munson, DF Young, TH Okiishi, 'Fundamentals of fluid mechanics', Wiley & Sons. RV Gilles, 'Fluid Mechanics and Hydraulics: Lectures and Problems', Schaum Series, Mc Graw Hill, 1975.

Semester: 3
Teaching unit: UEF 2.1.2
Subject 2:Rational mechanics
VHS: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student will be able to grasp the nature of a problem (static, kinematic or dynamic) in solid mechanics, he will have the tools allowing him to solve the problem within the framework of classical mechanics. This subject constitutes a prerequisite for the subjects: RDM and analytical mechanics.

Recommended prior knowledge

The student must first master the physics subject 1, which deals with point mechanics. Also, the mathematics subject 2 includes essential tools.

Content of the subject:

Chapter 1: Mathematical reminders (elements of vector calculation). 1 week

Chapter 2: Generalities and Basic Definitions 2 weeks

2.1 Definition and physical meaning of force
2.2 Mathematical representation of force
2.3 Operations on force (composition, decomposition, projection)
2.4 Type of force: point, linear, surface, volume
2.5 Classification of forces: internal forces, external forces.
2.6 Mechanical models: the material point, the solid body

Chapter 3: Static. 3 weeks

3.1 Axioms of statics
3.2 Connections, supports and reactions
3.3 Axiom of Bonds
3.4 Equilibrium conditions:
3.4.1 Concurrent forces
3.4.2 Parallel forces
3.4.3 Plane forces

Chapter 4: kinematics of the rigid solid. 3 weeks

4.1 Brief reminders on the kinematic quantities for a material point.
4.2 Solid Body Kinematics
4.2.1 Translational movement
4.2.2 Rotational movement around a fixed axis
4.2.3 Plane movement
4.2.4 Compound movement.

Chapter 5: Mass Geometry. 3 weeks

5.1 Mass of a material system

5.1.1 Continuous system
5.1.2. Discrete system
5.2 Integral formulation of the center of mass
5.2.1. Definitions (linear, surface and volume cases)
5.2.2 Discrete formulation of the center of mass
5.2.3 GULDIN's Theorems
5.3. Moment and product of inertia of solids
5.4. Inertia tensor of a solid
5.4.1 Special cases
5.42 Principal Axes of Inertia
5.5. Huyghens' Theorem
5.6. Moment of inertia of solids with respect to any axis.

Chapter 6: Dynamics of the rigid solid. **3 weeks**
6.1 Brief reminders on dynamic quantities for a material point.
6.2 Rigid body kinetics element:
6.2.1 Quantity of movement
6.2.2 Angular momentum
6.2.3 Kinetic energy
6.3 Equation of dynamics for a solid body
6.4 Angular Momentum Theorem
6.5 Kinetic Energy Theorem
6.6 Applications:
6.6.1 Pure translation case
6.6.2 Case of rotation around a fixed axis
6.6.3 Combined case of translation and rotation.

Assessment method:continuous assessment: 40%; final exam: 60%.

Bibliographic references:
(Depending on the availability of documentation at the establishment level, websites, etc.)

1. Elements of Rational Mechanics. S. Targ. Mir Publishing House, Moscow
2. Mechanics for Engineers. STATICS. Russell Edition. Ferdinand P. Beer
3. General mechanics. Course and corrected exercises. Sylvie Pommier. Yves Berthaud. DUNOD.
4. General Mechanics - Theory and Application, Series Editions. MURAY R. SPIEGEL schaum, 367p.
5. General mechanics – Exercises and solved problems with course reminders, Office of University Publications, Tahar HANI 1983, 386p.

Semester: 3
Teaching unit: UEM 2.1
Subject 1:Probabilities & Statistics
VHS: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Subject objectives

This module allows students to see the essential notions of probability and statistics, namely: statistical series with one and two variables, probability on a finite universe and random variables.

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Content of the material:

Part A: Statistics

Chapter 1: Basic Definitions **(1 week)**

A.1.1 Concepts of population, sample, variables, modalities
A.1.2 Different types of statistical variables: qualitative, quantitative, discrete, continuous.

Chapter 2: Single-variable statistical series **(3 weeks)**

A.2.1 Number, Frequency, Percentage.
A.2.2 Cumulative workforce, Cumulative frequency.
A.2.3 Graphical representations: bar chart, pie chart, stick chart. Polygon of frequencies (and frequencies). Histogram. Cumulative curves.
A.2.4 Position characteristics
A.2.5 Dispersion characteristics: range, variance and standard deviation, coefficient of variation.
A.2.6 Shape characteristics.

Chapter 3: Two-variable statistical series **(3 weeks)**

A.3.1 Data tables (contingency table). Scatter plot.
A.3.2 Marginal and conditional distributions. Covariance.
A.3.3 Linear correlation coefficient. Regression line and Mayer line.
A.3.4 Regression curves, regression corridor and correlation ratio.
A.3.5 Functional adjustment.

Part B: Probabilities

Chapter 1: Combinatorial Analysis **(1 Week)**

B.1.1Arrangements
B.1.2Combinations
B.1.3Permutations.

Chapter 2: Introduction to Probability **(2 weeks)**

B.2.1Algebra of events
B.2.2Definitions
B.2.3Probability spaces
B.2.4General probability theorems

Chapter 3: Conditioning and Independence **(1 week)**

B.3.1Packaging,
B.3.2Independence,
B.3.3Bayes' formula.

Chapter 4: Random Variables **1 Week**

B.4.1Definitions and properties,
B.4.2Distribution function,
B.4.3Mathematical expectation,
B.4.4Covariance and moments.

Chapter 5: Common Discrete and Continuous Probability Laws **3 Weeks**

Bernoulli, binomial, Poisson, ...; Uniform, normal, exponential, ...

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. D. Dacunha-Castelle and M. Duflo. Probability and Statistics: Fixed-Time Problems. Masson, 1982.
2. J.-F. Delmas. Introduction to probability calculus and statistics. ENSTA handout, 2008.
3. W.Feller. an Introduction to Probability Theory and its Applications, Volume 1. Wiley & Sons, Inc., 3rd edition, 1968.
4. G. Grimmett, D. Stirzaker, Probability and Random Processes, Oxford University Press, 2nd edition, 1992.
5. J. Jacod and P. Protter, Probability Essentials, Springer, 2000.
6. A. Montfort. Course in mathematical statistics. Economica, 1988.
7. A. Montfort. Introduction to Statistics. Ecole Polytechnique, 1991

Semester: 3

Teaching unit: UEM 2.1
Subject 2:Computer Science 3
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Subject objectives

Teach the student programming using easy-to-access software (mainly: Matlab, Scilab, Mapple, etc.). This subject will be a tool for carrying out practical work on numerical methods in S4.

Recommended prior knowledge
The basics of programming acquired in computer science 1 and 2

Content of the material:

TP 1: Presentation of a scientific programming environment (Matlab, Scilab, etc.) 1 week

TP 2: Script files and Data and variable types 2 weeks

TP 3: Reading, displaying and saving data 2 weeks

TP 4: Vectors and matrices 2 weeks

TP 5: Control instructions (for and while loops, if and switch instructions) 2 weeks

TP 6: Function files 2 weeks

TP 7: Graphics (Management of graphic windows, plot 2 weeks

TP 8: Using toolbox 2 weeks

Assessment method: Continuous assessment: 100%.

Bibliographic references:
(Depending on the availability of documentation at the establishment level, websites, etc.)
1- Computer Science: Programming and Simulation in Scilab 2014 - Authors: Arnaud Bégyn, Jean-Pierre Grenier, Hervé Gras.2- Scilab: From Theory to Practice - I. The Fundamentals. Book by Philippe Roux 2013.

Semester: 3

Teaching unit: UEM 2.1
Subject 3: Technical drawing
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives

This course will allow students to acquire the principles of representing parts in industrial design. Furthermore, this subject will allow the student to represent and read plans.

Recommended prior knowledge(brief description of the knowledge required to follow this course – Maximum 2 lines).

In order to follow this course, basic knowledge of the general principles of drawing is required.

Content of the material

Chapter 1: General Information. 2 weeks

1.1 Usefulnesstechnical drawings and different types of drawings.
1.2 Drawing materials.
1.3 Standardization(Types of lines, Writing, Scale, Drawing format and folding, Cartridge, etc.).

Chapter 2: Elements of Descriptive Geometry 6 Weeks

2.1 Concepts of descriptive geometry.
2.2 Orthogonal projections of a point - Drawing of a point - Orthogonal projections of a straight line (any and particular) - Drawing of a straight line - Traces of a straight line- Projections of a plane (Any and particular positions) - Traces of a plane.
2.3 Views: Choice and arrangement of views – Dimensioning – Slope and taper – Determination of the 3rd view from two given views.
2.4 Method of executing a drawing (layout, 45° line, etc.)
Application exercises and assessment (TP)

Chapter 3: Perspectives 2 weeks

Different types of perspectives (definition and purpose).
Application exercises and assessment (TP).

Chapter 4: Cuts and Sections 2 weeks

4.1 Sections, rules of standardized representations (hatching).
4.2 Projections and sections of simple solids (Projections and sections of a cylinder, of a prism, pyramid, cone, sphere, etc.).
4.3 Half-cut, Partial cuts, Broken cuts, Sections, etc.
4.4 Vocabularytechnical (terminology of machined shapes, profiles, piping, etc.
Application exercises and assessment (TP).

Chapter 5: Quotation **2 weeks**

5.1 General principles.

5.2 Quotation, tolerance and adjustment.

Exercisesapplications and evaluation (TP).

Chapter 6: Concepts on definition and assembly drawings and nomenclatures.

1 Week

Application exercises and assessment (TP).

Assessment method:Continuous assessment: 100%.

Bibliographic references:

(Depending on the availability of documentation at the establishment level, websites, etc.)

1. Industrial Designer's Guide Chevalier A. Hachette Technique Edition;
2. Technical drawing 1st part descriptive geometry Felliachi d. and Bensaada s. Edition OPU Algiers;
3. Technical drawing 2nd part industrial drawing Felliachi d. and bensaada s. Edition OPU Algiers;
4. First notions of technical drawing Andre Ricordeau Edition Andre Casteilla;
5. ماجد عبد الحميد ديوان المطبوعات الجامعية الجزائر **المدخل إلى الرسم الصناعي**
6. عمر أبو حنيك المعهد الجزائري للتقييس والملكية الصناعية طبع الحميد ديوان المطبوعات الجامعية الجزائر **مبادئ أساسية في الرسم الصناعي**

Recommendation: A large part of the practical work must be in the form of personal work at home.

Semester: 3

Teaching unit: UEM 2.1
Subject 4:Practical work on Waves and Vibrations
VHS: 3:00 p.m. (TP: 1:00 p.m.)
Credits: 1
Coefficient: 1

Teaching objectives

The objectives assigned by this program focus on introducing students to putting into practice the knowledge received on the phenomena of mechanical vibrations restricted to low amplitude oscillations for one or two degrees of freedom as well as the propagation of mechanical waves.

Recommended prior knowledge

Vibrations and waves, Mathematics 2, Physics 1, Physics 2.

Content of the material:

TP.1Mass – spring
TP.2 Simple pendulum
TP.3 Torsion pendulum
TP.4 Oscillating electric circuit in free and forced mode
TP.5 Coupled pendulums
TP.6 Transverse oscillations in vibrating strings
TP.7 Grooved pulley according to Hoffmann
TP.8 Electromechanical systems (The electrodynamic loudspeaker)
TP.9 The Pohl pendulum
TP.10 Propagation of longitudinal waves in a fluid.

Noticed: It is recommended to choose at least 5 TP from the 10 offered.

Assessment method:

Continuous assessment: 100%.

Bibliographic references:

(Depending on the availability of documentation at the establishment level, websites, etc.)

Semester: 3
Teaching unit: UED 2.1
Subject 1:Basic technology
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives

This course will enable students to acquire knowledge about the processes for obtaining and manufacturing parts and the techniques for assembling them.

Recommended prior knowledge

Content of the material

Chapter 1: Materials **3 Weeks**

1.1Metals and alloys and their designations
1.2 Plastics (polymers)
1.3 Composite materials
1.4 Othersmaterials

Chapter 2: Processes for obtaining parts without removing material4 Weeks

2.1 Casting, Forging, stamping, rolling, wire drawing, extrusion…. Etc.
2.2 Cutting, bending and stamping, etc.
2.3 Sintering and powder metallurgy
2.4 Profiles and Pipes (steel, aluminum);
- Workshop visits.

Chapter 3: Processes for obtaining parts by material removal **4 Weeks**

Turning, milling, drilling; adjustment, etc.
- Workshop visits and demonstrations.

Chapter 4: Assembly Techniques **4 Weeks**

- Bolting, riveting, welding, etc.

Assessment method: Final exam: 100%.

Bibliographic references:

- Mechanical technology manual, Guillaume SABATIER, et al Ed. Dunod.
- Memotech: materials production and machining BARLIER C. Ed. Casteilla
- Industrial Sciences MILLET N. ed. Casteilla
- Memotech: Industrial Technologies BAUR D. et al, Ed. Casteilla
- Dimensional metrology CHEVALIER A. Ed. Delagrave
- Drilling, milling JOLYS R and LABELL R. Ed. Delagrave
- Guide to mechanical manufacturing PADELLA P. Ed. Dunod
- Technology: first part, Bensaada S and FELIACHI d. Ed. OPU Algiers
- ديوان المطبوعات الجامعية الجزائر .Remove the water from the water

Semester: 3
Teaching unit: UED 2.1
Subject 2:Metrology
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives

Teach the student the precision criteria for manufacturing and assembling parts; Know and be able to choose, in different cases, the methods and means of controlling and measuring the dimensions and manufacturing defects of mechanical parts.

Recommended prior knowledge

Trigonometry, optics and others.

Content of the material

Chapter 1: General information on metrology **2 weeks**

1.1 Definition of the different types of metrology (Scientific, so-called laboratory, legal, industrial);
1.2 Metrological vocabulary, definition;
1.3 National and international metrology institutions.

Chapter 2: The International System of Measurement SI **3 Weeks**

2.1 Basic quantities and their units of measurement;
2.2 Additional sizes;
2.3 Derived quantities.

Chapter 3: Metrological characteristics of measuring devices **6 Weeks**

3.1 Error and uncertainty (Accuracy, precision, fidelity, repeatability, reproducibility of a measuring device
3.2 Classification of measurement errors
3.2.1Gross value;
3.2.2 Systematic error;
3.2.3 Corrected gross value.
3.3 Accidental errors
3.3.1Random errors;
3.3.2 parasitic errors;
3.3.3 Estimated systematic errors.
3.4 Confidence interval;
3.5 Technical uncertainty;
3.6 Total measurement uncertainty;
3.7 Complete measurement result;
3.8 Identification and interpretation of the specifications of a definition drawing for the control;
3.9 Basics of calibers, gauges and simple measuring instruments.

Chapter 4: Measurement and Control **4 Weeks**

4.1 Direct measurement of lengths and angles (use of ruler, caliper,

of the micrometer and the protractor);
4.2 Indirect measurement (use of comparator, standard gauges);
4.3 Dimension control (use of buffers, jaws, etc.);
4.4 Measuring and control machines used in mechanical workshops (use of pneumatic comparator, profile projector and roughness meter.

Assessment method: Final exam: 100%.

Bibliographic references:
(Depending on the availability of documentation at the establishment level, websites, etc.)

- Mechanical technology manual, Guillaume SABATIER, et al Ed. Dunod.
- Memotech: materials production and machining BARLIER C. Ed. Casteilla
- Industrial Sciences MILLET N. ed. Casteilla
- Memotech: Industrial Technologies BAUR D. et al, Ed. Casteilla
- Dimensional metrology CHEVALIER A. Ed. Delagrave
- Drilling, milling JOLYS R and LABELL R. Ed. Delagrave
- Guide to mechanical manufacturing PADELLA P. Ed. Dunod
- Technology: first part, Bensaada S and FELIACHI d. Ed. OPU Algiers
- ديوان المطبوعات الجامعية الجزائر .om the waterRemove the water fr

Semester: 3
Teaching unit: UET 2.1
Subject 1:Technical English
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives

This course should enable the student to have a language level where he will be able to use a scientific document and speak about his specialty and field in English at least with ease and clarity.

Recommended prior knowledge

English 1 and English 2

Content of the material

- Oral comprehension and expression, vocabulary acquisition, grammar, etc.
-nouns and adjectives, comparatives, following and giving instructions, identifying things.
-Use of numbers, symbols, equations.
- Measurements: Length, surface, volume, power, etc.
- Describe scientific experiments.
- Ccharacteristics of scientific texts.

Assessment method: Final exam: 100%.

Bibliographic references:

(Depending on the availability of documentation at the establishment level, websites, etc.)

Semester: 4
Teaching unit: UEF2.2.1
Subject 1:Thermodynamics 2
VHS: 45h00 (Course: 1h30,TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives: To establish the general ideas of thermodynamics and highlight their usefulness in engineering sciences. The objective is to be able to analyze energy systems using the prerequisites of the first year and to demonstrate what must be implemented for the study of water vapor and to introduce the study of the cycles of thermal and refrigerating machines.

Recommended prior knowledge: Thermodynamics of S2,Basic mathematics.

Content of the material:

Chapter 1: Reminders on the Basic Concepts of Thermodynamics 1 week
Reminder of the three principles of thermodynamics.

Chapter 2: Thermodynamic Properties of Pure Substances 2 weeks
State Diagrams (Ts Diagram, ph Diagram, hs Diagram), Thermodynamic Tables (Tables of Properties at Saturation, Tables of Properties of Superheated Steam), Equations of State (Equation of State of an Ideal Gas, Virial Developments, Van Der Waals Equation, Equations of State Derived from the Van Der Waals Equation, Reduced Variables and Law of Corresponding States, Semi-Empirical Equations of State)

Chapter 3: Thermodynamics of Vapors and Humid Air 2 weeks
Vapor Thermodynamics (Phase Change of a Pure Body, Calculation of State Variables, Vapor Content, Thermodynamic Diagrams and Tables), Humid Air (Characterization of humid air, Mollier Diagram, Elementary Operations on humid air).

Chapter 4: Compression of Gases 2 weeks
Classification of Compression Machines, Isentropic Compression, Polytropic Compression, Piston Compressors, Rotary Volumetric Compressors (Definitions).

Chapter 5: Gas Release 2 weeks
Expansion Machines, Adiabatic Expansion, Non-adiabatic Expansion, Work, Efficiency and Power Produced, Rotary Volumetric Compressors

Chapter 6: Motor Cycles 3 weeks
Carnot cycle, Otto cycle, Diesel cycle, Brayton cycle, Steam turbines, Rankine cycle (Reheating cycle, Extraction cycle, Cogeneration)

Chapter 7: Refrigeration Cycles 3 weeks
Gas refrigeration cycle, Single-stage vapor compression cycle, Refrigerants, Cold room thermal load, Two-stage compression cycles, Cascade cycles, Heat pumps

Assessment method:

Continuous assessment: 40%; Exam: 60%.

References:

1-Y. CENGEL, MA BOLES, 'Thermodynamics, a pragmatic approach', Edition De Boeck, la Chenelière, 2008. Translated from English by M. Lacroix of 'Thermodynamics, an Engineering approach'.
2-Andre HOUBERECHTSTechnical thermodynamics, volumes 1 and 2
3-SONNTAG and VAN WYLEN, 'Thermodynamics and Applications', translated from English, Fundamentals of classical thermodynamics' ed. McGraw Hill.
4- G. BRUHAT, Revised and expanded by A. KASTLER, 'Thermodynamics', Edition 6, Masson & Co.
5- R. Kling, 'Thermodynamics and applications', Technip Edition.
6-MJ MORAN and HOWARD M. SHAPIRO, Fundamentals of engineering Thermodynamic', J. Wyley & sons editors, 2006.
7- RAPIN-JACQUARD Refrigeration installations (technology), Dunod Edition; 2004
8- JP PEREZ 'Thermodynamics: Foundations and Applications', Dunod, Paris 2001.

Semester: 4
Teaching unit: UEF2.2.1
Subject 1:Mechanical manufacturing
VHS: 10:30 p.m. (Class: 1.5 hours)

Credits: 2
Coefficient: 1

Teaching objectives:

To provide the student with knowledge of product manufacturing techniques, particularly mechanical products.

Recommended prior knowledge:

Basic technology, materials science,

Content of the subject:

I- Theory of metal cutting

1.1 Cutting materials **(1 week)**
1.2 Cutting tool geometry **(1 week)**
1.3 Chip formation mechanism **(1 week)**
1.4 Cutting forces **(1 week)**
1.5 Heating (Cutting temperature)
1.6 Damage to cutting tools **(1 week)**
1.7 Methodology for choosing cutting parameters **(1 week)**

II- Machine Tool Technologies

2.1 Cutting movements **(1 week)**
2.2 Characterization of a machine tool (Main components) **(2 weeks)**
- Pin
- Built
- Slides

2.3 Drivetrains **(6 weeks)**

- Movement transmission mechanisms
- Lathes, planers and vice-files, Drills, milling machines, Broaching machines, Cylindrical and surface grinders, etc.

Assessment method: Exam: 100%.

Bibliographic references:

1- Engineering Techniques 2000 B.BM.BT. January 2000 Printed in France by ImprimerieStrasbourgeoise Schiltighein- ISTRAIN2- Roger Bonetto Flexible Production Workshops 2nd Edition Hermes 1987-Paris3- G. Levallant; M.Dessoly; P.Géodossi; P.Leroux; J.C.Moulet; G.Poulachon; P.Robert
Chip removal machining - from technology to industrial applications
Ensam. Edition Eyrolles N° 7211- June 2005 Paris4- Manufacturing Elements Edition Ellipses. Copyright 1995 Paris5- Michel Ahby, Choice of Materials in Mechanical Design; Dunod, 19996- Claude Hazard, Numerical Control of MO, Foucher edition, Paris 19847- Gonzalez, CN by computer, Foucher edition Paris 1985.8- Philippe DEPEYRE, Course “Mechanical Manufacturing”, Faculty of Sciences and Technologies, University of Reunion, Year 2004-2005

Semester: 4
Teaching unit: UEF2.2.1
Subject 1:Mathematics 4
VHS: 45h00 (Course: 1h30,TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This course covers the differential and integral calculus of complex functions of a complex variable. The student mustmaster the different techniques for solving functionsand integrals tocomplex and special variables.

Recommended prior knowledge:
Mathematics 1, Mathematics 2 and Mathematics 3.

Content of the material:
Complex Variable Functions and Special Functions

Chapter 1: Holomorphic Functions. Cauchy-Riemann Conditions3 weeks

Chapter 2: Entire Series 3 weeks
Radius of convergence. Domain of convergence. Expansion in power series. Analytic functions. Laurent series and expansion in Laurent series.

Chapter 3: Cauchy's Theory 3 weeks
Cauchy's theorem; Cauchy's formulas. Singular point of functions, general method for calculating complex integrals

Chapter 4: Applications 4weeks
Equivalence between holomorphy and analyticity. Maximum theorem. Liouville's theorem. Rouché's theorem. Residue theorem. Calculation of integrals by the residue method.

Chapter 5: Special Functions 2weeks
Special Euler functions: Gamma, Beta functions, applications to integral calculations

Assessment method:
Continuous assessment: 40%; Exam: 60%.

Bibliographic references:
1- Henri Catan, Elementary Theory of Analytic Functions of One or More Complex Variables. Publisher Hermann, Paris 1985.
2- Jean Kuntzmann, Complex Variable. Hermann, Paris, 1967. Undergraduate textbook.
3- Herbert Robbins Richard Courant. What is Mathematics?, Oxford University Press, Toronto, 1978. Classic popular work.
4- Walter Rudin, Real and Complex Analysis. Masson, Paris, 1975. Second cycle textbook.

Semester: 4
Teaching unit: UEF2.2.2
Subject 1:Numerical methods
VHS: 45h00 (Course: 1h30, TD: 1h30**)**
Credits: 4
Coefficient: 2

Teaching objectives: Familiarization with numerical methods and their applications in the field of mathematical calculations.

Recommended prior knowledge: Math1, Math2, Computer Science1 and Computer Science 2

Content of the material:

Chapter 1: Solving nonlinear equations f(x)=0 (**3 weeks)**

1. Introduction to calculation errors and approximations,
2. Introduction to methods for solving nonlinear equations,
3. Bisection method,
4. Method of successive approximations (fixed point),
5. Newton-Raphson method.

Chapter 2: Polynomial Interpolation (**2 weeks)**

1. General introduction,
2. Lagrange polynomial,
3. Newton polynomials.

Chapter 3 Function Approximation: (**2 weeks)**

1. Approximation method and quadratic mean.
2. Orthogonal or pseudo-orthogonal systems. Approximation by orthogonal polynomials
3. Trigonometric approximation

Chapter 4: Numerical Integration (**2 weeks)**

1. General introduction,
2. Trapeze method,
3. Simpson's method,
4. Quadrature formulas.

Chapter 5: Solving Ordinary Differential Equations (**2 weeks)**
(initial condition or Cauchy problem).

1. General introduction,
2. Euler's method,
3. Improved Euler method,
4. Runge-Kutta method.

Chapter 6: Direct method of solving systems of linear equations
(2 weeks)

1. Introduction and definitions,
2. Gaussian method and pivoting,
3. LU factorization method,
4. ChoeleskiMMt factorization method,
5. Thomas Derivative Algorithm (TDMA) for diagonal sorting systems.

Chapter 7: Method of Approximate Resolution of Systems (**2 weeks)**
of linear equations

1. Introduction and definitions,
2. Jacobi method,
3. Gauss-Seidel method,
4. Use of relaxation.

Assessment method:
Continuous assessment: 40%; Exam: 60%.

References:

1. BREZINSKI (C.), Introduction to the practice of numerical calculation. Dunod, Paris (1988).
2. G. Allaire and SM Kaber, 2002. Numerical linear algebra. Ellipses.
3. G. Allaire and SM Kaber, 2002. Introduction to Scilab. Corrected practical exercises in linear algebra. Ellipses.
4. G. Christol, A. Cot and C.-M. Marle, 1996. Differential calculus. Ellipses.
5. M. Crouzeix and A.-L. Mignot, 1983. Numerical analysis of differential equations. Masson.
6. S. Delabrière and M. Postel, 2004. Approximation methods. Differential equations. Scilab applications. Ellipses.
7. J.-P. Demailly, 1996. Numerical Analysis and Differential Equations. Grenoble University Press, 1996.
8. E. Hairer, S. P. Norsett and G. Wanner, 1993. Solving Ordinary Differential Equations, Springer.
9. CIARLET (PG). Introduction to numerical matrix analysis and optimization. Masson, Paris (1982).

Semester: 4
Teaching unit: UEF2.2.3
Subject 1:Resistance of materials
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives: Know the methods of calculating the resistance of construction elements and determine the variations in the shape and dimensions (deformations) of the elements under the action of loads.

Recommended prior knowledge: Analysis of functions; rational mechanics.

Content of the subject:

Chapter 1: INTRODUCTIONS AND GENERALITIES **(2 weeks)**

1.1 Goals and Assumptions of Strength of Materials
1.2 Classification of solids (beam, plate, shell)
1.3 Different types of loads
1.4 Connections (supports, embeddings, ball joints)
1.5 General Principle of Equilibrium – Equilibrium Equations
1.6 Principles of cutting – Reduction elements
1.7 Definitions and sign conventions of:
- Normal force N,
- Shear force T,
- Bending moment M

Chapter 2: TRACTION AND COMPRESSION **(3weeks)**

2.1 Definitions
2.2 Normal tensile and compressive stress
2.3 Elastic deformation in tension/compression
2.4 Tensile/Compressive Strength Condition

Chapter 3: SHEAR **(2 weeks)**

3.1 Definitions
3.2 Simple shear – pure shear
3.3 Shear stress
3.4 Elastic shear deformation
3.5 Shear strength condition

Chapter 4: GEOMETRIC CHARACTERISTICS **(3 weeks)**
STRAIGHT SECTIONS

4.1 Static moments of a cross section
4.2 Moments of inertia of a cross section
4.3 Formulas for transforming moments of inertia

Chapter 5: TWIST **(2 weeks)**

5.1 Definitions
5.2 Tangential or sliding stress
5.3 Elastic torsional deformation
5.4 Torsional strength condition

Chapter 6: SIMPLE PLANE BENDING **(3 weeks)**

6.1 Definitions and assumptions
6.2 Shear forces, bending moments
6.3 Diagram of shear forces and bending moments
6.4 Relationship between bending moment and shear force

6.5 Deformation of a beam subjected to simple bending (arrow)

5. 6.6 Calculation of constraints and dimensioning

Assessment method:
Continuous assessment: 40%; Exam: 60%.

References:

- Mechanics for Engineers – Statics. Ferdinand P. Beer and Russell Johnston, Jr., McGraw-Hill, 1981.
- Resistance of materials, P. STEPINE, Editions MIR; Moscow, 1986.
- Strength of Materials 1, William A. Nash, McGraw-Hill, 1974.
- Resistance of materials, S. Timoshenko, Dunod, 1986

Semester: 4
Teaching unit: UEM2.2
Subject 1:Computer-aided design
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives: This teaching will allow students to acquire the pprinciples of representing parts in industrial drawing. Furthermore, this subject will allow the student to represent and read plans.

Recommended prior knowledge: Technical Drawing..

Content of the material:

1. PRESENTATION OF THE CHOSEN SOFTWARE **(4weeks)**
(SolidWorks, Autocad, Catia, Inventor, etc.)
1.1 Introduction and history of DAO;
1.2 Configuration of the chosen software (interface, shortcut bar, options, etc.);
1.3 Software reference elements (software aids, tutorials, etc.);
1.4 Backup of files (part file, assembly file, drawing file, backup procedure for delivery to the teacher);
1.5 Communication and interdependence between files.

2. CONCEPT OF SKETCHES **(3 weeks)**
2.1 Sketch tools (point, line segment, arc, circle, ellipse, polygon, etc.);
2.2 Sketch relationships (horizontal, vertical, equal, parallel, hilly, fixed, etc.);
2.3 Dimensioning of sketches and geometric constraints.

3.3D MODELING **(3 weeks)**
3.1 Concepts of planes (front plane, right plane and top plane);
3.2 Basic functions (extrusion, material removal, revolution):
3.4 Display functions (zoom, multiple views, multiple windows etc.):
3.5 Editing tools (Erase, Shift, Copy, Mirror, Adjust, Extend, Move):
3.6 Creation of a sectional view of the model.

4.3D MODEL PLANNING **(3 weeks)**
4.1 Editing the plan and the title block:
4.2 Choice of views and layout:
4.3 Object Dressings and Properties (Hatching, dimensioning, text, tables, etc.)

5. ASSEMBLIES **(2weeks)**
5.1 Assembly constraints (parallel, coincidence, coaxial, fixed, etc.):
5.2 Production of assembly drawings:
5.3 Assembly drawing and parts list:
1. Exploded view.

Assessment method:
Continuous assessment: 100%.

References:

- Solidworks bible 2013 Matt Lombard, Edition Wiley,
- Technical drawing, Saint-Laurent, GIESECKE, Frederick E. Editions du renouveau pédagogique Inc., 1982.
- Exercises in drawing mechanical parts and assemblies using SolidWorks software,Jean-Louis Berthéol,François Mendes,

- CAD accessible to all with SolidWorks: from creation to realization volume 1Pascal Rétif,
- Industrial Designer's Guide, ChevalierA, Hachette Technique Edition,

Semester: 4
Teaching unit: UEM2.2
Subject 2:Practical work on fluid mechanics
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
The student puts into practice the knowledge in the subject of fluid mechanics taught in S3.

Recommended prior knowledge:
Subjects: fluid mechanics and physics 1.
Content of the material:

- Viscometer
- Determination of linear and singular pressure losses
- Flow measurement
- Water hammer and mass oscillations
- Verification of Bernoulli's theorem
- Jet impact
- Flow through an orifice
- Visualization of flows around an obstacle
- Determination of Reynolds Number: Laminar and Turbulent Flow

Assessment method:
Continuous assessment: 100%.

Semester: 4
Teaching unit: UEM2.2
Subject 3:Numerical Methods Practical Work
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives: Programming of different numerical methods with a view to their applications in the field of mathematical calculations using a scientific programming language (matlab, scilab, etc.).

Recommended prior knowledge: Numerical method, Computer Science 2 and Computer Science 3.

Content of the material:

1. Solving nonlinear equations **(3 weeks)**
   - 1.1. Bisection method
   - 1.2. Fixed point method
   - 1.3. Newton-Raphson method
   - 1.4.
2. Interpolation and approximation **(3 weeks)**
   - 2.1. Newton interpolation
   - 2.2. Chebyshev approximation
3. Digital integrations **(3 weeks)**
   - 3.1. Rectangle Method
   - 3.2. Trapezius Method
   - 3.3. Simpson's method
4. Differential equations **(2weeks)**
   - 4.1. Euler's method
   - 4.2. Runge-Kutta methods
5. Systems of linear equations **(4 weeks)**
   - 5.1. Gauss-Jordon method
   - 5.2. Crout decomposition and LU factorization
   - 5.3. Jacobi method
   - 5.4. Gauss-Seidel method

Assessment method:
Continuous assessment: 100%.

References:

1. Algorithms and numerical calculation: practical work solved and programming with Scilab and Python software /Jose Ouin, . -Paris: Ellipses, 2013 . - 189 p.

2. Mathematics with Scilab: calculation guide, programming, graphic representations; compliant with the new MPSI program /Bouchaib Radi, ;Abdelkhalak El Hami. -Paris: Ellipses, 2015 . - 180 p.

Applied numerical methods: for scientists and engineers /Jean-Philippe Grivet, . -Paris: EDP sciences, 2009 . - 371 p

Semester: 4
Teaching unit: UEM2.2
Subject 4:Practical work on the resistance of materials
VHS: 3:00 p.m. (TP: 1:00 p.m.)
Credits: 1
Coefficient: 1

Teaching objectives:apply the different stresses studied in the materials resistance module and determination of the characteristics of materials from simple mechanical tests.

Recommended prior knowledge: Resistance of materials, materials science.

Content of the material:

TP N°1: Simple tensile-compression tests
TP N°2: Torsion test
TP N°3: Simple bending test
TP N°4: Resilience test
TP N°5: Hardness test

Assessment method:
Continuous assessment: 100%.

Semester: 4
Teaching unit: UEM2.2
Subject 5:Mechanical Manufacturing TP
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 1
Coefficient: 1

Teaching objectives:apply the different machining processes.

Recommended prior knowledge: Mechanical manufacturing and technical drawing courses.
Content of the material:

TP n° 1: Turning a cylindrical part with 2 diameters with operations of dressing and cartography

-Execution of draft and definition drawings.
-Determination of cutting regimes and development of the machining range of the part.
-Preparation of tools, machine and measuring instruments.
-Positioning, clamping the blank, setting up and adjusting the machine.
-Carrying out operations and the part.

TP n° 2: Milling and drilling of a prismatic part with mainly milling and drilling phases.

-Definition of the shape, dimensions, tolerances and surface conditions of the part (definition drawing)
- Draft drawing.
-Determination of cutting regimes and development of the machining range of the part (without the grinding phase).
-Cutting the rough draft.
-Preparation of tools, machine(s) and measuring instruments.
-Positioning, clamping the blank, setting up and adjusting the machine.
- Carrying out operations and the part

TP n° 3: Rectificationplane and examination of surface conditions (Use of the room from TP no. 2)

-Analysis of the draft and definition drawings from TP n°2
-Determination of grinding regimes and development of the complete range of machining of the part (with the grinding phase).
-Preparation of tools, machine and surface condition measuring instruments (roughness).
-Positioning, clamping the blank, setting up and adjusting the machine.
-Carrying out the rectification phase and checking the surface condition.

TP n° 4: welding

- Preparation of parts to be assembled
- Choice of filler metal
- Production of the welding bead
- Cleaning and control

Assessment method: Continuous assessment: 100%.

Semester: 4
Teaching unit: UED2.2
Subject 1:Industrial electricity
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives: The objective of the program is to provide Mechanical Engineering students with a set of knowledge that is essential and necessary for the physical understanding of the essentials of electrotechnical phenomena.

Recommended prior knowledge: The fundamental teachings of physical sciences acquired in the common core of sciences and technology.

Content of the material:

Chapter 1 – Electrical Circuits **(4 weeks)**
- 1.1 Introduction
- 1.2 Current and voltage in electrical circuits
- 1.3 Resistors and equivalent circuit.
- 1.4 Work and power
- 1.5 Single-phase and three-phase electrical circuits.

Chapter 2 – Magnetic Circuits **(3 weeks)**
- 2.1 Magnetism and electricity
- 2.2 Fundamental laws
- 2.3 Magnetic materials and circuits

Chapter 3 – The Transformers **(2 weeks)**
- 3.1 Description
- 3.2 Equivalent circuits
- 3.3 Measuring transformers
- 3.4 Special transformers

Chapter 4 – Electrical Machines **(3 weeks)**
- 4.1 Direct current machines (shunt, separate, series excitation)
- 4.2 Synchronous machines
- 4.3 Asynchronous machines
- 4.4 Special machines
- 4.5 Connection of three-phase motors

Chapter 5 – Electrical Measurements **(3 weeks)**
- 5.1 Measurement in physics
- 5.2 Measurement quality – errors
- 5.3 Structure of digital display devices
- 5.4 Measurements of currents and voltages
- 5.5 Power and energy measurements
- 5.6 Wiring diagrams for an electrical installation - Calculation of wire section.

Assessment method:
Review: 100%.

References:

- Exercises and problems in electrical engineering: basic concepts, electrical networks and machines; Luc Lasne; Dunod edition 2011.
- Electrical engineering: modeling and simulation of electrical machines; Rachid Abdessemed; Ellipse edition 2011.
- Electrical circuits: continuous, sinusoidal and impulse regime, Jean-Paul Bancarel, Ellipse edition 2001.
- Electrical Circuit Analysis, Charle K. Alexander and Matthew Sadiku; de boeck edition. 2012.

Semester: 4
Teaching unit: UED2.2
Subject 2:Materials Science
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:
This subject allows the student to know the classification of materials as well as the basic notions of crystallography; equilibrium diagrams and heat treatments.

Recommended prior knowledge:
The fundamental subjects of S1 and S2.

Content of the material:

Chapter 1: General information **(03 weeks)**

1.1 Classification of materials:
- 1.1.1 Metals and alloys
- 1.1.2 Ceramics and glass
- 1.1.3 Polymers
- 1.1.4 Composite materials

1.2 Areas of use
1.3 Structure of materials: amorphous materials and crystalline materials
1.4 Concepts of crystallography

Chapter 2: Equilibrium diagrams **(04 weeks)**

2.1 Crystallization of materials
- 2.1.1 Principle of crystallization and cooling curves
- 2.1.2 Crystallization of a pure metal
- 2.1.3 Crystallization of an alloy

2.2 Equilibrium diagram of two completely miscible metals
2.3 Equilibrium diagram of two partially miscible metals

Chapter 3: Iron-carbon equilibrium diagram **(04 weeks)**

3.1 Characteristics of iron and carbon
3.2 Iron-carbon equilibrium diagram
3.3 Iron-cementite equilibrium diagram
3.4 Standard designation of steels and cast irons
3.5 Standard designation of other alloy steels

Chapter 4: Heat treatments and thermochemical diffusion treatment **(03 weeks)**

1. Heat treatments
   - Annealing
   - Tempering
   - Income
2. Thermochemical treatments
   - Cementation
   - Nitriding
   - Carbonitriding

Assessment method:

Review: 100%.

References:

- Materials Science and Engineering;OfWilliam D. Callister.Dunod.
- Materials. T1 Properties, applications and design, Michael F. Ashby, David RH Jones Collection: Sciences Sup, Dunod
- Materials. T2 Microstructures, implementation and design; Michael F. Ashby, David RH Jones Collection: Sciences Sup, Dunod
- Materials, Jean-Marie Dorlot, Jean-Paul Baïlon.Polytechnic International Press.
- Structures and Materials: The Mechanical Explanation of Forms, James Gordon

Semester: 4
Teaching unit: UET2.2
Subject 1:Expression and Communication Techniques
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:
This teaching aims to develop the student's skills, on a personal or professional level, in the field of communication and expression techniques.

Recommended prior knowledge:
Languages (Arabic; French; English)

Content of the material:

Chapter 1:Research, analyze and organize information 3 weeks
Identify and use locations, tools and documentary resources, Understand and analyze documents, Create and update documentation.

Chapter 2:Improve the ability to express oneself 3 weeks
Take into account the communication situation, produce a written message, communicate orally, produce a visual and audiovisual message.

Chapter 3:Improve communication skills in interaction situations 3 weeks
Analyze the interpersonal communication process, Improve face-to-face communication ability, Improve group communication ability.

Chapter 4:Develop autonomy, organizational and communication skills within the framework of a project approach 6 weeks
Position yourself in a project and communication approach, Anticipate action, Implement a project:Presentation of a report on a practical work (Homework).

Assessment method: Final exam: 100%.

References:
1-Jean-Denis Commeignes 12 methods of written and oral communication – 4th grade edition, Michelle Fayet and Dunod 2013.
2- Denis Baril; Sirey, Techniques of written and oral expression; 2008.
3- Matthieu Dubost Improve your written and oral expression all the keys; Edition Ellipses 2014.

Semester: 5
Teaching unit: UEF 3.1.1
Subject 1: Fluid Mechanics 2
VHS: 67h30 (Lecture: 3h00; Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

This subject is a continuation of fluid mechanics 1, it focuses on fluid kinematics, analysisbased on the concept of control volumeand to dimensional and similarity analysis.

Recommended prior knowledge:

MDF 1, Thermodynamics, Physics 1 and 2.

Content of the subject:

Chapter 1. Fluid Kinematics **(6 Weeks)**

Reference systems. Continuity equation: differential form. Concepts of volume flow and mass flow. Rotational and irrotational flows. Circulation and vorticity

Irrotational or velocity potential flows. Plane flows. Elementary potential flows. Superposition of simple flows. Graphical superposition method. Elements of complex potential theory. Elementary potential flows expressed in complex form. Conformal transformation method

Chapter 2.Analysis based on the concept of control volume.(5 Weeks)

2.1 Conservation of mass - continuity equation. Derivation of the continuity equation. Fixed non-deformable control volume. Non-deformable control volume in motion. Deformable control volume.

2.2 Newton's Second Law - Linear Equations of Momentum and Momentum. Derivation of the Linear Equation of Momentum. Application of the Linear Equation of Momentum. Derivation of the Linear Equation of Momentum. Application of the Linear Equation of Momentum.

Chapter 3. Dimensional Analysis and Similarity **(4 Weeks)**

Introduction. Dimensional analysis. Similarity. Applications.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. R. Comolet, “Experimental Fluid Mechanics”, Publisher Masson, 1976, Volumes I, II, III.
2. RB Bird, WE Stewart, EN Lightfoot, “Transport Phenomena”, Wiley editor, 1960.
3. Rjucsh K. Kundu, IM Cohen, “Fluid Mechanics”, 2nd Edition, Academic Press, 2002.
4. DP Kesseler and RA Greenkorn, “Momentum, Heat, and Mass transfer: Fundamentals”, M. Dekker, 1999.
5. TC Papanastasiou, GC Georgiou and AN Alexandrou, “Viscous fluid flow”, CRC Press LLC, 2000.
6. G. Emanuel, “Analytical Fluid, Dynamics”, 2nd edition, CRC Press, 2000.
7. RW Fox, AT Mc Donald and PJ Pritchard, “Introduction to fluid mechanics”, sixth edition, Wiley and sons editor, 2003.

Semester: 5
Teaching unit: UEF 3.1.1

Subject 2:Transferof heat1
VHS: 45h00 (Lecture: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Appreciate the heat-conducting properties of common materials, evaluate the rates of heat transfer by conduction in steady state for common geometries. Applications to rectangular fins. Understand the mechanisms of heat transfer between a fluid and a solid surface.

Recommended prior knowledge:

Thermodynamics, MDF, Mathematics.

Content of the subject:

Chapter 1. Introduction of heat transfer and position with respect to the thermodynamics. **(1 Week)**

Chapter 2. Basic laws of heat transfer **(2 Weeks)**

Chapter 3. Heat Conduction **(7 Weeks)**

Fourier's Law. Thermal conductivity and orders of magnitude for common materials. Discussion of the parameters on which thermal conductivity depends. Energy equation, simplifying assumptions, and different forms. Spatial and initial boundary conditions. The four linear conditions and their practical significance. Under what conditions can they be realized? Some solutions to the heat equation, in Cartesian, cylindrical, and spherical coordinates with linear conditions. Case of conductive systems with heat sources. The stationary electrical analogy. The longitudinal rectangular fin problem: Fin equation. Resolution. Calculation of fin efficiency and effectiveness. Generalization of the fin concept. Application to the radial fin of uniform profile.

Chapter 4. Convective Heat Transfer **(5 Weeks)**

Mechanisms of convective heat transfer. Parameters involved in convective transfer. Highlight the different types of convective transfer: Forced, natural and mixed convection. Cite common examples. Distinguish between laminar and turbulent convective transfer in both forced and natural modes. Methods for solving a convection problem (Dimensional analysis and experiments, integral methods for approximate boundary layer equations, solving equations representing convection and analogy with similar phenomena such as mass transfer). Dimensional analysis combined with experiments: Pi theorem, reveal the most used dimensionless numbers in forced and natural convection (Reynolds, Prandtl, Grashoff, Rayleigh, Peclet and Nusselt). Explain the meaning of these numbers.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. JF Sacadura coordinator, “Heat transfers: Introduction and in-depth study”, Lavoisier 2015.
2. Kreith, F.; Boehm, RF; And. al., “Heat and Mass Transfer”, Mechanical Engineering Handbook Ed. Frank Kreith, CRC Press LLC, 1999.
3. Bejan and A. Kraus, “Heat Handbook”, J. Wiley and sons 2003.

4. F. Kreith and MS Bohn. “Principles of Heat Transfer”, 6th ed. Pacific Grove, CA: Brooks/Cole, 2001.
5. YA Cengel, “Heat and Mass Transfer”, McGraw Hill.
6. HD Baehr and K. Stephan, “Heat and Mass transfer”, 2nd revised edition, Springer Verlag editor, 2006.
7. JL Battaglia, A. Kuzik and JR Puiggali, “Introduction to heat transfers”, Dunod 2010.
8. By Giovanni B. Bedat, “Heat transfer”, Cépaduès, 2012.
9. JP Holman, “Heat Transfer”. 9th ed. New York: McGraw-Hill, 2002.
10. FP Incropera and DP DeWitt. “Introduction to Heat Transfer”, 4th ed. New York: John Wiley & Sons, 2002.
11. J. Taine, JP Petit, “Heat transfer and mechanics of anisothermal fluids”, Dunod, 1988.
12. NV Suryanaraya. “Engineering Heat Transfer”, St. Paul, Minn.: West, 1995.
13. HD Baehr and K. Stephan, “Heat and Mass transfer”, 2nd revised edition, Springer Verlag.

Semester: 5
Teaching unit: UEF 3.1.2
Subject 1: Turbomachines 1
VHS: 45h00 (Lecture: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Apply fluid mechanics to technical systems such as pumps and hydraulic turbines. Know how to size and install pumps. Understand the origin of pump failures. Calculate, select, and install different types of hydraulic turbines according to requirements.

Recommended prior knowledge:

MDF1, Thermodynamics.

Content of the material:

Chapter 1.Definitions and general theory of turbomachines (4 Weeks)
Classification of turbomachines, general theory, Euler's theorem. Velocity diagram. Height, power. Efficiency of turbomachines. Component of transferred energy. Degree of reaction, load variation, degree of reaction.

Chapter 2. Pumps (3 Weeks)
General relations, Centrifugal pumps and axial pumps, Descriptions, speed triangles, efficiencies.

Chapter 3. Similarities in turbomachinery (3 Weeks)
General relations, Rateau invariants, Other coefficients, Machines in similar operation, Generalization, Specific speed.

Chapter 4. Cavitation in Pumps (2 weeks)
Origin and criteria of cavitation, Manifestation, Influence of different factors, Similarity of cavitation.

Chapter 5. Hydraulic Turbines (3 Weeks)
The Pelton turbine, The reaction turbine,The Francis turbine, the Kaplan turbine.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. P. HENRY, “Hydraulic Turbomachines”, Polytechnic and University Presses of Romandie, 1992.
2. M. Sedille, “Hydraulic and Thermal Turbomachines”, Masson, 1970.
3. P. Henry, “Hydraulic Turbomachines”, 1992.
4. Peng, “Fundamentals of Turbomachinery”, Wiley and Sons, 2008.
5. M. Pluviose, “Turbomachinery Engineering, Circuits, Vibrations, Unsteady Effects and Solved Exercises”, Energy Engineering, Ellipses 2003.
6. P. Chambadal, “The gas turbine”, 1997.
7. R. Bidard and J. Bonnin, “Energy and turbomachines”, Eyrolles 1979.
8. L. Vivier, Steam and gas turbines, 1965

9. M. Pluviose, "Energy Conversion by Turbomachines", 2009
10. J. Krysinski, "Turbomachines, general theory", OPU, Algiers, 1986.
11. R. Bidard, J. Bonnin, "Energy and Turbomachines", Eyrolles, Paris 1979.
A. Jaumotte, "Centrifugal turbopumps", PU Brussels, 1979.
12. Jaumotte, "Turbomachines: fans, blowers and centrifugal compressors", PU of Brussels, 1979.
13. Adam Troskolanski, "Turbopumps (Theory, Layout and Construction)", Eyrolles 1977.

Semester: 5
Teaching unit: UEF 3.1.2
Subject 2:Energy conversion
VHS: 45h00 (Lecture: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Apply the concepts of thermodynamics acquired in previous years to various energy-producing or energy-consuming machines. Use exergy analysis to identify opportunities for improvement or failures in real thermodynamic systems. Energy analysis of systems involving combustion.

Recommended prior knowledge:

Thermodynamics

Content of the material:

Chapter 1. Single-Phase Power Cycles (4 Weeks)

Definitions. Carnot cycle. Otto cycle. Diesel cycle. Combined cycle. Joule-Brayton cycle. Ericsson cycle. Stirling cycle. - Preheating or regenerative cycle - Multi-stage cycle with regenerator, cooling and intermediate heating. Different components of a power plantthermalgas.

Chapter 2. Two-Phase Power Cycles (4 Weeks)

Reminders on phase change. Rankine cycle. Hirn cycle. Reheating cycle. Cycle with one or more steam withdrawals. Mixed cycle (gas-captor). Steam thermal power plants.Facilitieshybrids (solar-gas). Cogeneration installations. Concept on nuclear power plants.

Chapter 3. Exergy and exergy analysis of thermodynamic systems(3 Weeks)

Application to power plantsthermalgas and steam thermal power plants.

Chapter 4. Thermodynamics of combustion (3 Weeks)

Properties of mixtures, stoichiometric combustion, heat of formation and calorific values, adiabatic flame temperature. Chemical kinetics: Elementary reactions, chain reactions and free radical production, recombinations, equilibrium constants, reaction rates. Simplified combustion models, pressure dependence, partial equilibrium and quasi-steady states. Autoignition and spontaneous ignition, effect of pressure on temperature.self-ignition, spark ignition, critical heat flux for ignition.

Assessment method:

Controlcontinuous: 40% ; Exam: 60%.

Bibliographic references:

1. RE Sonntag and JG Van Wylen, “Fundamentals of classical thermodynamics”,Ed. J. Wiley & Sons,1978.
2. Kaster, “Thermodynamics 6th edition”, Masson, 1968.
3. R. Kling, “Thermodynamics and application”, Technip Edition.
4. M. Bertin, JP Faroux and J. Renault, “Thermodynamics”, Dunod University, 1981.
5. MW Zemansky and RH Ditmann, “Heat and Thermodynamic”, 7th edition, McGraw Hill, 1981.
6. JP Perez, “Thermodynamics, Foundations and Applications”, second edition, Masson, 1997.
7. S. Mc Allister, Jyh-Yuan Chen and A. Carlos Fernandez-Pello, “Fundamentals of Combustion Processes”, Springer editor, 2011.
8. T. Poinsot and D. Veynante, “Theoretical and Numerical Combustion”, Edwards editor, 2005.

Semester: 5
Teaching unit: UEM 3.1
Subject 1:Heat Transfer TP
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Practically illustrate the knowledge acquired in the heat transfer course.

Recommended prior knowledge:

Heat transfer, thermodynamics.

Content of the material:

Plan some experiments related to heat transfer according to the means available.

Fashiondevaluation:

Continuous assessment: 100%.

Semester: 5
Teaching unit: UEM 3.1
Subject 2:TP Turbomachines 1
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
To practically illustrate the behavior of hydraulic turbomachines, pumps and hydraulic turbines.

Recommended prior knowledge:
Turbomachines.

Content of the material:
Plan some experiments related to turbomachines according to the available means.

Assessment method:
Continuous assessment: 100%.

Semester: 5
Teaching unit: UEM 3.1
Subject 3:TPEnergy conversion
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
Putting the principles of energy conversion into practice on energy machines.

Recommended prior knowledge:
Energy conversion.

Content of the material:
Plan some experiments related to energy conversion according to the means available.

Assessment method:
Continuous assessment: 100%.

Semester: 5
Teaching unit: UEM 3.1
Subject 4:Measurement and instrumentation
VHS: 37h30 (Lecture: 1h30; Practical work: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

Acquirethe different experimental and measurement techniques, particularly those used in energy. Learn to choose the right instruments and sensors to set up your own experiments. Be able to'appreciate mistakes.

Recommended prior knowledge:

Thermodynamics, MDF, Heat transfer, electricity…

Content of the material:

Chapter 1. Measurements of thicknesses and lengths **(5 Weeks)**

Mechanical instruments, Pneumatic instruments, Optical instruments, Error assessment.

Chapter 2. Temperature Measurements **(5 Weeks)**

Thermocouples, thermistors, infrared detectors, pyrometers. Calibrating thermal sensors. Errors related to thermal sensors. Selecting sensors. Automatic measurement acquisition and acquisition cards.

Chapter 3. Measurements of flow rates, velocities and pressures **(5 Weeks)**

The different flow meters, The choice and errors related to each type, Pitot, Präsil and Prandtl tubes, Hot wire and hot film anemometers, Dopler laser anemometers, PIV. Pressure measurements: Mechanical sensors, piezoelectric sensors. Electrical measurements, Signal processing, Interpreting results, Developing experiments.

Practical work.

Depending on the means of the establishment and the availability of the material, at least five (05) practical work must be carried out in this subject.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. RJ Goldstein, “Fluid Mechanics Measurements”, 1983.
2. JO Hinze, “Turbulence”, Mc Graw-Hill Book Cie, Inc, 1975.
3. CG Lomas, “Fundamentals of hot wire anemometry”, Cambridge Univ. Press. 1986.
4. E. Guyon, JP Hulin and L. Petit, “Physical hydrodynamics”, CNRS Ed. 2001.

Semester: 5
Teaching unit: UED 3.1
Subject 1: Concept of machine elements
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

To provide students with scientific and technological training in the field of mechanical construction through knowledge of standard machine elements and parts used in the construction of mechanical structures, their standardization as well as mechanical power transmission.

Recommended prior knowledge:

Industrial Design, RDM, Mechanical Manufacturing.

Content of the subject:

Chapter 1. Introduction **(2 Weeks)**
General (Mechanical construction, Design study, Safety coefficient, Standards, Economy, Reliability)

Chapter 2. Threaded assemblies **(3 Weeks)**
Screws, bolts, studs, resistance calculation (shear, matting, bending, tightening of a hyperstatic system, etc.)

Chapter 3. Gears **(3 Weeks)**
Cylindrical gear (straight and helical teeth), Bevel gear (straight and helical teeth), worm screw.

Chapter 4. Shafts and Axes **(2 Weeks)**
Calculation of the preliminary diameter of the axes and shafts, Checking of the shafts and axes for fatigue.

Chapter 5. Motion transmission (calculation and dimensioning) **(3 Weeks)**
Plain bearings and thrust bearings, Rolling bearings and thrust bearings, Friction wheels, Belts, Chains, ...

Chapter 6. Couplings, clutches and brakes **(2 Weeks)** **(2**

Assessment method:

Review: 100%.

Bibliographic references:

1. BJ Morvan, “The Gears”, Ed.:Delcourt G. Productions,01/2004.
2. G. Henriot, “The Gears”, Ed.: Dunod
3. A. Pouget, T. Berthomieu, Y. Boutron, E. Cuenot, “Structures and mechanisms - Mechanical construction activities”, Ed. Hachette Technique.
4. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu. “Precises of Mechanical Construction”, Volume 1, Project studies, components, standardization, AFNOR, NATHAN, 2001.

5. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu, “Precis de Construction Mécanique”, Volume 3, Projects-calculations, dimensioning, standardization, AFNOR, NATHAN, 1997.
6. Y. Xiong, Y. Qian, Z. Xiong, D. Picard, “Mechanical Form”, Construction Parts, EYROLLES, 2007.
7. JL FANCHON, “Mechanics Guide”, NATHAN, 2008.
8. F. ESNAULT, “Mechanical Construction”, Power Transmission, Volume 1, Principles and Eco-design, DUNOD, 2009.
9. F. ESNAULT, “Mechanical Construction”, Power Transmission, Volume 2, Applications, DUNOD, 2001.
10. F. ESNAULT, “Mechanical Construction”, Power Transmission, Volume 3, Power Transmission by Flexible Links, DUNOD, 1999.
11. Bawin, V. and Delforge, C., “Mechanical Construction”, Original Edition: G. Thome, Liège, 1986.
12. M. Szwarcman, “Elements of machines”, Lavoisier edition, 1983.
13. WL Cleghorn, “Mechanics of machines”, Oxford University Press, 2008.

Semester: 5
Teaching unit: UED 3.1
Subject 2:Regulation and control
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

Recognize the main techniques for regulating mechanical systems and the components used.

Recommended prior knowledge:

Mathematics, numerical methods.

Content of the material:

Chapter 1. Control Systems Terminology **(1Week)**

Functional diagram of a controlled system, Constituent elements of a functional diagram of a controlled system.

Chapter 2. Laplace Transform **(2 weeks)**

Definitions and properties.

Chapter 3. Transfer Functions **(2 weeks)**

Algebra of functional diagrams and transfer function of systems.

Chapter 4. Study of a first-order servo-controlled system **(3 Weeks)**

Definition and transfer function, System response to different input signals.

Chapter 5. Study of a second-order servo-controlled system **(3 weeks)**

Definition and transfer function, Response of the system to different input signals, Representation of the system in the complex plane.

Chapter 6. BODE and Nyquist diagram of servo-controlled systems **(2 weeks)**

Chapter 7. Stability study of servo-controlled systems **(2 weeks)**

Analytical stability criteria according to Routh and Hurrwitz, Geometric criterion according to Nyquist.

Assessment method:

Review: 100%.

Bibliographic references:

1- H. Bourles, “Linear systems from modeling to control”, Lavoisier, 2006, Paris.
2- JM Flans, “Industrial Regulation”, Hermès, 1994, Paris.
3- P. de Larminat, “Automatic control of linear systems”, Hermès, 1996, Paris.
4- E. Godoy, “Industrial Regulation Collection: Technology and Engineering”, Dunod, L'Usine Nouvelle, 2007.
5- JM. Flaus, “Industrial regulation: PID, predictive and fuzzy regulators”, Hermes Sciences, 1994.

Semester: 5
Teaching unit: UET 3.1
Subject 1:Environment and sustainable development
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

To raise student awareness of the relationship between energy, the environment and sustainable development and to control sources of pollution; reduce them in order to guarantee sustainable development.

Recommended prior knowledge:

Fluid mechanics, fundamental thermodynamics, heat transfer, and environmental characteristics.

Content of the material:

Chapter 1. Introduction to the concept of environment **(2 Weeks)**

Definition of the environment, General definition, Legal definition, Brief history, Man and the environment, How man has modified his environment, Demography scapegoat.

Chapter 2. The concept of sustainable development **(2 Weeks)**

Definition, Brief history, The fundamental principles of sustainable development, The ethical principle, The precautionary principle, The prevention principle, The objectives of sustainable development, the environmental challenges of sustainable development.

Chapter 3. Environment and Natural Resources **(4 Weeks)**

Introduction, Resources, Water, Air, Fossil fuels (oil, natural gas, coal, etc.), Other energies (solar, wind, hydraulic, geothermal, biomass, etc.), Mineral elements, Biodiversity, Soils, Food resources.

Chapter 4. Substances **(4 Weeks)**

The different types of pollutants, Regulated pollutants, Organic compounds, Heavy metals, Particles, Chlorofluorocarbons, The effects of different substances on the environment, Greenhouse effect and climate change, Destruction of the ozone layer, Acidification, eutrophication and photochemistry, Acid rain. Ozone peaks; Effects on materials; Effects on ecosystems: forests, freshwater reserves, Effects on health. The different types of emitters, Corinair nomenclature.

Chapter 5. Environmental Preservation **(3 Weeks)**

Introduction of new materials, Reserving oil for noble uses, Improving energy efficiency, Recycling, Economic, legal and regulatory mechanisms for environmental preservation, The role of public authorities in resolving environmental problems, The possible option of private solutions, Current environmental policies, The polluter-pays principle, Ecological taxation: ecotaxes, The market for tradable emission permits.

Assessment method:

Exam: 100%.

Bibliographic references:

1- De Jouvenel, B., "The theme of the environment, Analysis and forecasting", 10, pp. 517533, 1970.
2- Faucheux S., Noël JF, "Economics of natural resources and the environment", Armand Collin, Paris.
3- Reed D. (Ed.), "Structural adjustment, environment and sustainable development", l'Harmattan, Paris, 1995.
4- Vivien F-.D, "History of a word, history of an idea: sustainable development in the test of time", Ed. scientifiques et médicale Elsevier ASA, pp. 19-60, 2001.
5- Boutaud, Aurélien, Gondran, Natasha, "The Ecological Footprint", Paris: La Découverte, 2009.
6- Lazzeri, Yvette (Dir.), "preface by Gérard Guillaumin, Sustainable development, businesses and territories: towards a renewal of practices and tools", Paris, L'Harmattan, 2008.

Semester: 6
Teaching unit: UEF 3.2.1
Subject 1:Turbomachines 2
VHS: 67h30 (Lecture: 3h00; Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

Apply the laws of fluid mechanics and thermodynamics to energy-producing and mechanical energy-consuming machines using compressible fluids. Understand the problems associated with this type of machine during operation.

Recommended prior knowledge:

Thermodynamics and fluid mechanics.

Content of the material:

Chapter 1. Presentation of an axial turbine **(1 week)**
Concepts of aerodynamics of lifting profiles, lift and drag, loss angle.

Chapter 2. Static and total thermodynamic quantities **(1 week)**
Definition of the total state and graphical representation on the (h,s) diagram.

Chapter 3. General equations of turbomachines **(3 weeks)**
Conservation of total enthalpy in fixed channel, conservation of rothalpy in moving channel.

Chapter 4. Study of nozzles (simple nozzle and Laval nozzle) **(3 weeks)**
Different operating regimes (subsonic, sonic, supersonic), Sonic blocking, Straight-front shock waves.

Chapter 5. Theory of the single-stage turbine **(1 week)**
Principle and definition, expressions of specific work, speed triangle, role of the fixed channel and moving channel, thermodynamic representation of actual operation on the (h,s) diagram, losses in the stator, losses in the rotor, losses by remaining speed, concept of available drop, aerodynamic efficiency.

Chapter 6. Study of the Curtis wheel. Multicellular turbines-Reaction turbines(1 week)
Principle and definition, representation of actual operation on the diagram (h,s), Aerodynamic efficiency.

Chapter 7. Compressors **(3 weeks)**
Velocity triangle, Thermodynamic evolution of the fluid in the case of a compression machine, Calculation of specific work and power, efficiencies, pumping phenomenon in compressors.

Chapter 8. Fans **(2 weeks)**
Role of turbomachines in industrial installations, technological aspects.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. P. HENRY, "Hydraulic Turbomachines", Polytechnic and University Presses of Romandie, 1992.
2. M. Sedille, "Hydraulic and Thermal Turbomachines", Masson 1970.
3. P. Henry, "Hydraulic Turbomachines", 1992.
4. Peng, "Fundamentals of Turbomachinery", Wiley and Sons 2008.
5. M. Pluviose, "Turbomachinery Engineering, Circuits, Vibrations, Unsteady Effects and Solved Exercises", Energy Engineering, Ellipses, 2003.
6. P. Chambadal, "The gas turbine", 1997
7. R. Bidard and J. Bonnin, "Energy and turbomachines", Eyrolles, 1979.
8. L. Vivier, "Steam and gas turbines", 1965.
9. M. Pluviose, "Energy Conversion by Turbomachines", 2009.
10. J. Krysinski, "Turbomachines, general theory", OPU, Algiers, 1986.
11. R. Bidard, J. Bonnin, "Energy and Turbomachines", Eyrolles, Paris, 1979.
12. Jaumotte, "Centrifugal turbopumps", PU Brussels, 1979.
13. Jaumotte, "Turbomachines: fans, blowers and centrifugal compressors", PU of Brussels, 1979.
14. Adam Troskolanski, "Turbopumps (Theory, Design and Construction)", Eyrolles, 1977.

Semester: 6
Teaching unit: UEF 3.2.1
Subject 2:Internal combustion engines
VHS: 45h00 (lesson: 1h30; TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Understand how different types of internal combustion engines work, both thermodynamically and mechanically.

Recommended prior knowledge:

Thermodynamics and mathematics of L1 and L2.

Content of the material:

Chapter 1. General Information (2 Weeks)

Principle of operation and classification of thermal engines, Fuels of internal combustion engines.

Chapter 2. Thermodynamics of engine cycles (4 Weeks)

The Beau de Rochas cycle, The Diesel cycle, The Sabathé cycle, Real cycles and efficiencies, Energy balance, Fuel supply for gasoline engines, Ignition system for gasoline engines, Combustion.

Chapter 3. Real cycle of an internal combustion engine (4 Weeks)

Admission, Compression, Combustion, Expansion, Exhaust, Indicated parameters, Effective parameters, Construction of the theoretical diagram indicated.

Chapter 4. Dynamics of Reciprocating Engines (3 Weeks)

Crank-rod system: Kinematic study – Dynamic study. Distribution system: Kinematic study – Dynamic study. Balancing.

Chapter 5 Performance and Characteristics of Reciprocating Engines (2 Weeks)

Performance parameters, Standards, Characteristics: Full load - partial loads - universal.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. JB Heywood, “Internal Combustion Fundamentals”, McGraw Hill Higher Education, 1989.
2. P. Arquès, “Design and construction of alternative engines”, Ellipse, 2000.
3. JC. Guibet, “Fuels and Engines”, 1997.
4. P. Arquès, “Reciprocating internal combustion engines (Technology)”, Masson edition, 1987.
5. UY Famin Gorban, AI, Dobrovolsky VV, Lukin AI et al., “Marine Internal Combustion Engines”, Leningrad: Sudostrojenij, 1989, 344p.
6. W. Diamant, “Internal combustion engines”, ECAM, 1984.
7. M. Desbois, R. Armao, “The Diesel Engine, Edition Foucher”, Paris, 1974.
8. M. Menardon, D. Jolivet, “The Engines, Edition Chotard”, Paris, 1986.
9. M. Desbois, “The automobile: T1: 4-stroke and two-stroke engines. T2: Transmission and operating components”, Edition Chotard, 1989.
10. P. Arques, “Combustion”, Ellipses, Paris, 1987.
11. H. Memetau, “Functional techniques of the automobile: The engine and its auxiliaries”, Dunod, Paris, 2002.

Semester: 6
Teaching unit: UEF 3.2.2
Subject 1:Refrigerating machines and heat pumps
VHS: 45h00 (Lecture: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Learn the techniques of cold production and the main technical elements used in this vast field.

Recommended prior knowledge:

Thermodynamics, turbomachines, regulation, machine elements.

Content of the material:

Chapter 1. General Information **(2 Weeks)**

History of refrigeration, Carnot refrigeration cycle, Coefficient of performance of the Carnot cycle.

Chapter 2. Thermodynamic cycle of a vapor compression refrigeration machine

(4 Weeks)

Representation of the basic thermodynamic cycle (on a Ts and Ph diagram), Representation of the practical thermodynamic cycle (on a Ts and Ph diagram), Thermal balance of the thermodynamic cycle, Concept of refrigerant fluids, Study of performance (COP, etc.), Industrial applications of refrigeration.

Chapter 3. Components of a vapor-compression refrigerating machine **(3 Weeks)**

Compressors, Evaporators, Condensers, Expansion devices.

Chapter 4. Other types of refrigerating machines **(3 Weeks)**

Operating principle of an absorption refrigeration machine, Air refrigeration cycle.

Chapter 5. Thermodynamic Cycle of a Heat Pump **(3 Weeks)**

Fluid diagram, Cycle reversal valve, Performance study (summer and winter seasons), Different types of heat pumps (geothermal, etc.).

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. H. Recknagel, ER. Schramek,E. Sprenger, "Climate engineering**",**Dunod**,**2013.
2. W. Maake,H.-J. Eckert,JL. Cauchepin, “The Pohlmann - Technical Manual of Refrigeration”,PYC Books.
3. J. Desmons, "Engineer's aide-mémoire: Climate engineering”,Dunod**.**
4. F. Meunier, D. Mugnier, “Solar air conditioning. Thermal or photovoltaic”, DUNOD, 2013.
5. F. Meunier,P. Rivet,MF. Terrier, "Industrial Refrigeration - 2nd Edition», DUNOD, 2010.
6. Horst Herr, “Energy and climate engineering Heating, cooling, air conditioning”,Dunod Tech2014.

Semester: 6
Teaching unit: UEF 3.2.2
Subject 2:Heat Transfer 2
VHS: 45h00 (Lecture: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Evaluate convected or radiated flows in different situations. Be able to model a thermal problem and solve it in stationary cases and simple geometries. Be able to make the right choice of materials for any thermal application.

Recommended prior knowledge:

Thermodynamics, heat transfer1 and mathematics of L1 and L2.

Content of the material:

Chapter 1. Continuation of convection transfers from the first half of the year (5 Weeks)

Approximate resolution of boundary layer equations: Integral methods. Completely treat the cases of the horizontal flat plate in forced convection and that of the vertical flat plate in natural convection. Deduce the relations Nu=f(Re, Pr) and Nu=f(Gr,Pr). Exact solution of laminar forced convection on a horizontal flat plate and a vertical flat plate in natural convection. Deduce the relations Nu=f(Re, Pr) and Nu=f(Gr,Pr), compare with the approximate analysis. Laminar convection in a cylinder. Assumptions and resolution of the problem. Deduction of the Nusselt with imposed temperature and imposed flow.

Chapter 2. Heat Transfer by Radiation (6 Weeks)

Introduction: Solid angle concepts. Mechanism of surface and volume radiative transfer. Definitions and general laws (luminance, illumination, intensity, emittance, etc.). Bouguer formula, Kirchhoff's law and Draper's law. The black body (NB). Planck's law. Flux emitted by the NB in a spectral band. The Stefan-Boltzmann law. Radiative properties of surfaces and relationships between them. Radiative exchanges between two infinitely extended parallel planes separated by a transparent medium. Screen concepts.Radiative exchange between two black concave surfaces. Concepts of form factors. Reciprocity relations. Summation rule. Superposition rule. Symmetry rule. Form factors between infinitely long surfaces. The crossed-string method.Flux lost by a concave surface. Radiative exchanges between any n surfaces forming an enclosure. Enclosure rules for form factors. Illuminance-radiosity method for evaluating exchanged fluxes. Electrical analogy in radiative transfer.Radiative exchange between surfaces separated by an emitting and absorbing semi-transparent medium (STM), simplified method not involving the radiative transfer equation. Radiative properties of STM, Hottel spherical cap. Emissivities and absorptivities of gaseous STM mixtures.

Chapter 3. Heat Exchangers and Boilers: (4 Weeks)

Notions on exchangers: Classification – Different types – Industrial uses – Evolution of temperatures in exchangers – Exchanged flow – Overall exchange coefficient – Methods for calculating exchangers – Mean logarithmic temperature difference method DTLM – Number of transfer units method NUT – Comparison of the two methods. Boilers: Different types of boilers - Study of losses - Efficiency.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. JF Sacadura coordinator, "Heat transfers: Introduction and in-depth study", Lavoisier, 2015.
2. Kreith, F., Boehm, RF, et. al., "Heat and Mass Transfer, Mechanical Engineering Handbook", Ed. Frank Kreith, CRC Press LLC, 1999.
3. A. Bejan and A. Kraus, "Heat Handbook Handbook", J. Wiley and sons 2003.
4. F. Kreith and MS Bohn, "Principles of Heat Transfer", 6th ed. Pacific Grove, CA: Brooks/Cole, 2001.
5. YA Cengel, "Heat transfer, a practical approach", McGraw Hill, 2002.
6. YA Cengel, "Heat and Mass Transfer", McGraw Hill.
7. HD Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag editor, 2006.
8. JL Battaglia, A. Kuzik and JR Puiggali, "Introduction to heat transfers", Dunod, 2010.
9. By Giovanni B. Bedat, "Heat transfer", Cépaduès, 2012.
10. JP Holman, "Heat Transfer", 9th ed. New York: McGraw-Hill, 2002.
11. FP Incropera and DP DeWitt, "Introduction to Heat Transfer". 4th ed. New York: John Wiley & Sons, 2002.
12. J. Taine, JP Petit, "Heat transfer and mechanics of anisothermal fluids", Dunod, 1988.
13. MF Modest. "Radiative Heat Transfer", New York: McGraw-Hill, 2014.
14. R. Siegel and JR Howell, "Thermal Radiation Heat Transfer", 3rd ed. Washington, DC: Hemisphere, 2003.
15. N.V. Suryanaraya, "Engineering Heat Transfer," St. Paul, Minn.: West, 1995.
16. HD Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag.

Semester: 6
Teaching unit: UEM 3.2
Subject 1:End of Cycle Project
VHS: 45h00 (TP: 3h00)
Credits: 4
Coefficient: 2

Teaching objectives:

Assimilate knowledge from different subjects in a comprehensive and complementary manner. Put into practice the concepts taught during training. Encourage students' sense of autonomy and initiative. Teach them to work in a collaborative environment by stimulating their intellectual curiosity.

Recommended prior knowledge:

The entire Bachelor's program.

Content of the material:

The theme of the End of Cycle Project must come from a joint choice between the tutor and a student (or a group of students: pairs or even trios). The substance of the subject must necessarily fit with the objectives of the training and the real skills of the student (Bachelor's level). It is also preferable that this theme takes into account the social and economic environment of the establishment. When the nature of the project requires it, it can be subdivided into several parts.

Noticed :

During the weeks when students are familiarizing themselves with the purpose of their project and its feasibility (bibliographic research, search for software or hardware necessary to carry out the project, revision and consolidation of teaching directly linked to the subject, etc.), the subject manager must use this face-to-face time to remind students of the essential content of the two subjects.Writing Methodology''And ''Presentation Methodology''covered during the first two semesters of the common core.

At the end of this study, the student must submit a written report in which he must set out as explicitly as possible:

- The detailed presentation of the study theme, emphasizing its relevance in its socio-economic environment.
- The means implemented: methodological tools, bibliographic references, contacts with professionals, etc.
- Analysis of the results obtained and their comparison with the initial objectives.
- Criticism of the observed deviations and possible presentation of other additional details.
- Identification of the difficulties encountered by highlighting the limits of the work carried out and the follow-up to be given to the work carried out.

The student or group of students finally presents their work (in the form of a brief oral presentation or on a poster) in front of their tutor and an examiner who can ask questions and thus assess the work accomplished in terms of technique and presentation.

Assessment method:

Controlcontinuous: 100%.

Semester: 6
Teaching unit: UEM 3.2
Subject 2:TPrefrigeration machines and heat pumps
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Understand the practical behavior of refrigeration machines, their performance and their limitations.

Recommended prior knowledge:

Course ofRefrigeration machines and heat pumps

Content of the material:

Plan some experience with refrigeration machines and heat pumps depending on the availability of resources.

Assessment method:

Continuous assessment: 100%.

Semester: 6
Teaching unit: UEM 3.2
Subject 3:Internal combustion engine TP
VHS: 3:00 p.m. (TP: 1:00 p.m.)
Credits: 1
Coefficient: 1

Teaching objectives:

Apply the knowledge learned in class to evaluate the performance of internal combustion engines.

Recommended prior knowledge:

Internal combustion engine course.

Content of the material:

Plan some experiments related to internal combustion engines depending on the availability of resources.

Assessment method:

Continuous assessment: 100%.

Semester: 6
Teaching unit: UEM 3.2
Subject 4:TP regulation and control
VHS: 10:30 p.m. (TP: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Demonstrate typical examples of regulation and control on energy systems. For example, temperature or pressure regulation on refrigeration machines, flow regulation on exchangers, levels on boilers, rotation speed on turbomachines, etc.

Recommended prior knowledge:

Courses in regulation and applied energy subjects.

Content of the material:

Plan some experiences related to theregulation and control.

Assessment method:

Continuous assessment: 100%.

Semester: 6
Teaching unit: UED 3.2
Subject 1:Renewable energies
VHS: 10:30 p.m. (lesson: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

To introduce the student to possible work projections in the field of renewable energies such as domestic hot water production installations or drying installations, electricity production in arid zones and areas not served by the electricity network, the concept of service provided, the use of wind, biomass and geothermal energy, etc.

Recommended prior knowledge:

Thermodynamics, heat transfer, turbomachinery, etc.

Content of the subject:

Chapter 1. Solar Astronomy **(2 Weeks)**

Chapter 2. Algerian solar deposit **(2 Weeks)**

Chapter 3. Thermal Conversion of Solar Energy **(4 Weeks)**

Flat-plate solar collectors, Solar concentration: Cylindrical, parabolic-cylindrical-paraboloid, heliostats, Applications of solar thermal conversion, Solar heat storage.

Chapter 4. Photovoltaic Conversion **(3 Weeks)**

Physics of photovoltaic cells, The different types of direct conversion cells, The use of direct conversion panels and the concept of service provided.

Chapter 5. Wind Energy **(2 Weeks)**

Wind energy resources, The different types of wind turbines, The use of wind turbines,

Chapter 6.Geothermal energy **(1 Weeks)**

Geothermal energy: Deposits in Algeria and use,

Chapter 7.Biomass(1 Week)

Biomass: The use of waste.

Assessment method:

Review: 100%.

Bibliographic references:

1. B. Equer, J. Percebois, “Photovoltaic solar energy, 1: Physics and technology of photovoltaic conversion”, Ellipses, 1993.
2. P. Gipe, “Wind power: Renewable energy for home, farm, and business”, Chelsea green publishing co, 2004.
3. A. Filloux, "Integrating renewable energies», 2014.
4. J. Vernier, "Renewable energies», 2014.
5. B. Wiesenfeld, "Promises and realities of renewable energies», 2013.

6. C. Dubois"The Wind Power Guide, Techniques and Practices",Eyrolles, 2009.
7. D. The Gouriérès, "Wind turbines Theory, design and practical calculation",Editions du Moulin Cadiou, 2008.
8. A. Damien, "Biomass energyDefinitions, resources and modes of transformation", 2013.
9. J. Lemale,Geothermal energy,Dunod, 2012.
10. P. Van de Maele,Jean-François Rocchi. "Geothermal energy and heat networks», Publisher(s):ADEME,BRGM, 2003.
11. RH Charlier and Charles W. Finkl, "Ocean Energy: Tide and Tidal Power", 2008.
12. ME McCormick, "Ocean Wave Energy Conversion", 2007.
13. B. Multon, "Marine Renewable Energy Handbook", 2011.
14. P. Prouzetand A. Monaco, "Development of Marine Resources", 2014.

Semester: 6
Teaching unit: UED 3.2
Subject 2:Cryogenics
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

Understand the different processes for producing very low temperatures. Techniques for liquefying natural gas and producing liquid air compounds.

Recommended prior knowledge:

Thermodynamics and heat transfer.

Content of the subject:

Chapter 1. Thermodynamic reminders (1 Week)

Chapter 2. Gas cycles (Brayton) - study of the turbojet(2 Weeks)

Chapter 3. Phase-change cycles (Rankine) (2 Weeks)
Study of compression and expansion steam turbine cycles.

Chapter 4. Main industrial methods for obtaining low temperatures (3 Weeks)
Chapter 5. Ideal Liquefaction Cycles and Minimal Work(3 Weeks)

Chapter 6. Real liquefaction cycles(2 Weeks)

Chapter 7. Gas Separation(2 Weeks)
Descriptive aspects of some processes for obtaining industrial gases.

Assessment method:

Review: 100%.

Bibliographic references:

1. RB Scott, “Cryogenic engineering”, Van Nostrand, Princeton, 1959.
2. RR Conte, “Elements of cryogenics”, Masson, Paris, 1970.
3. GG Haselden, “Cryogenic fundamentals”, Academic Press, London, 1971.
4. RA Barron, “Cryogenic systems”, Oxford University Press, New York, 1985.
5. BA Hands, “Cryogenic engineering”, Academic Press, London, 1986.
6. SW Van Sciver, “Helium cryogenics”, Plenum Press, New York, 1989.
7. KD Timmerhaus and TM Flynn, “Cryogenic process engineering”, Plenum Press, New York, 1989.

Semester: 6
Teaching unit: UET 3.2
Subject 1: Professional project and business management
VHS: 10:30 p.m. (Class: 1.5 hours)
Credits: 1
Coefficient: 1

Teaching objectives:

Prepare and master the methodological tools necessary for professional integration at the end of studies, prepare for the job search. Be made aware of entrepreneurship by presenting an overview of management knowledge useful for the creation of activities and be able to implement a project.

Content of the material:

Chapter 1: Business and Society (3 weeks)

The company: Definition and objectives of the company. Different forms of business, company structure, personnel and partners of the company.
Different types of business (VSE, SME, SMI, ETI, GE)
The company: Definition and objectives of the company
Different types of business (SARL, EURL, SPA, SNC, etc.)
Difference between business and corporation.

Chapter 2: Operation and organization of the company (2 weeks)

Method of organization and operation of the company
The main functions of the company (production company, service company, etc.)
Company structure (definition and characteristics)
Different types of structures (functional, divisional, multidivisional structure, Hierarchical-functional ''staff and line'').
Additional activities of the company (partnership, subcontracting, etc.).

Chapter 3: How to get into a company (3 weeks)

Personnel needs and quality (senior executives, managers, technicians, workers, etc.)
Where to find the job offer (ANEM, section, internet, etc.)
How to go about it (the application, the CV)
The different types of job interviews and how to approach one.
Types of employment contracts (permanent and fixed-term contracts)
Salary (how a pay slip is calculated).

Chapter 4: How to Start Your Own Business (3 weeks)

The business creator's journey (the idea, the capital, financial aid, etc.)
How to find a good idea.
Financial aid schemes for investment (ANSEJ, CNAC, ANDI, ANGEM, PNR)

Chapter 5: Study of a business creation project (4 weeks)

Studying a business creation project requires the promoter to make the effort to plan and write down in detail the phases and steps that he will have to take to get his business off the ground.
Market research(sales department, marketing, etc.).
Technical study(location, equipment and machinery requirements, production capacity, etc.).
Financial study(turnover, salary costs, expenses and consumption, taxes, etc.).
Mini project for the study of a business creation project

Assessment method:100% review

Bibliographic references:

1. *-Antoine Melo "Business Management" Melo France edition 2016*
2. *-Thomas Durand "Business Management" Paperback edition 2016*
3. *-Philippe Guillermic "Business Management Step by Step" Pocket Edition 2015*
4. *-Guy Raimbault "Management Tools" Chihab Algiers edition 1994*
5. *-Institute of Financial Technology ''Accounting Initiation''OPU Algiers 1993*
6. *-Christian Bultez ''Guide and instructions for procedures'' Nathan Paris edition 1993*